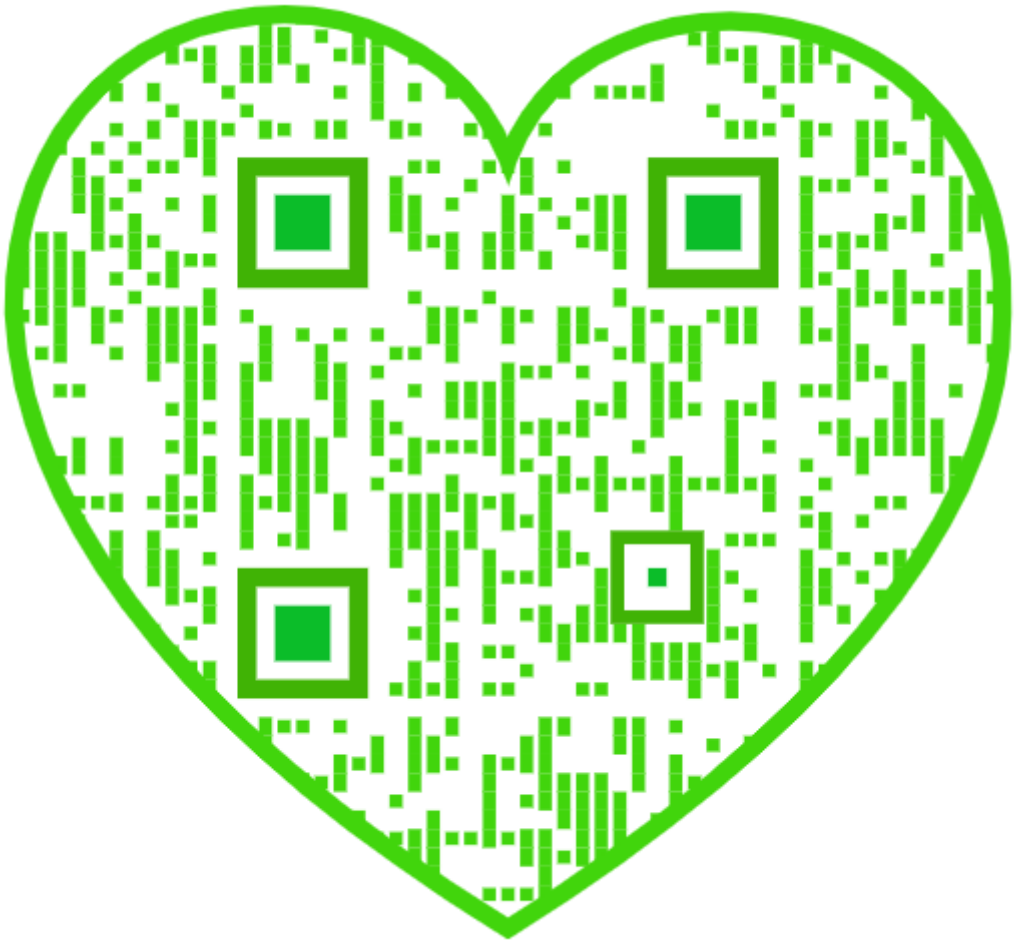

THE

INTERNATIONAL ENCYCLOPÆDIA

OF

SURGERY.

VOL. VII.

THE

INTERNATIONAL ENCYCLOPÆDIA

OF

SURGERY

A SYSTEMATIC TREATISE

ON THE

THEORY AND PRACTICE OF SURGERY

BY

AUTHORS OF VARIOUS NATIONS

EDITED BY

JOHN ASHHURST, Jr., M.D., LL.D.

BARTON PROFESSOR OF SURGERY AND PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PENNSYLVANIA HOSPITAL, ETC.

ILLUSTRATED WITH CHROMO-LITHOGRAPHS AND WOOD-CUTS

IN SEVEN VOLUMES

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PREFACE.

THE object of this Supplementary Volume is to furnish to the readers of the INTERNATIONAL ENCYCLOPÆDIA OF SURGERY a brief but sufficient account of such additions to both Surgical Science and Surgical Art as have been brought forward during the seven years which have elapsed since the revised edition of the original book was published, and as have seemed of sufficient importance to justify their incorporation in a work of this character, which makes no claim to be an ephemeris of theoretic novelties, but rather to be a trustworthy digest of accepted and established facts.

In carrying out the intention to make the volume a SUPPLEMENT to its predecessors, the authors of the several articles have had constantly in mind the necessity of not unnecessarily repeating what is already in the possession of the reader; and very variable amounts of space have therefore been occupied in the consideration of the several subjects discussed. Some topics were so elaborately presented in the earlier portions of the work that, in the absence of any great quantity of new material, they have in the present volume been summarily dealt with; while as regards other subjects the activity of surgeons and surgical writers has been so intense that in some instances more space has been required for the supplementary record than seven years ago was needed for the original article. As an example may be mentioned the subject of Cerebral Surgery, which may almost be said to have come into existence since the revised edition of the Encyclopædia was published.

As with the previous volumes, the editor is responsible for the general arrangement of the work, for those articles, three in number, which bear his own name, and for a very few notes which may be distinguished by their inclusion within brackets [thus]; but for the facts and opinions

expressed in the other articles the entire responsibility rests with their respective authors.

The illustrations which have been inserted are such as it is believed will really serve to elucidate the text, but none have been included for mere pictorial effect. The thanks of the editor are due to the trustees of the Fiske Prize Fund for permission to use a number of cuts illustrative of the Article on Diseases of the Joints.

JOHN ASHHURST, JR.

PHILADELPHIA,
2000 WEST DELANCEY PLACE,
October, 1895.

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P. S. CONNER,
B. FARQUHAR CURTIS,
EDWARD COWLES,
GWILYM G. DAVIS,
JOHN B. DEAVER,
CHARLES W. DULLES,
HAROLD C. ERNST,
F. FORCHHEIMER,
J. McFADDEN GASTON,
W. C. GLASGOW,
ROBERT P. HARRIS,
RICHARD H. HARTE,
FRED. KAMMERER,
OTTO G. T. KILIANI,
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CHARLES B. KELSEY,
EDWARD L. KEYES,
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ASSISTANT PROFESSOR OF BACTERIOLOGY IN HARVARD UNIVERSITY, PHYSICIAN TO OUT-PATIENTS AT THE MASSACHUSETTS GENERAL HOSPITAL, ETC.

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J. McFADDEN GASTON, M.D.,

PROFESSOR OF THE PRINCIPLES AND PRACTICE OF SURGERY IN THE SOUTHERN MEDICAL COLLEGE, ATLANTA, GA.; PRESIDENT OF THE AMERICAN ACADEMY OF MEDICINE; EX-PRESIDENT OF THE SOUTHERN SURGICAL AND GYNÆCOLOGICAL ASSOCIATION, AND OF THE SECTION OF ANATOMY AND SURGERY IN THE AMERICAN MEDICAL ASSOCIATION.

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PROFESSOR OF DISEASES OF THE SKIN IN THE PHILADELPHIA POLYCLINIC; PHYSICIAN TO THE DEPARTMENT FOR SKIN DISEASES, HOWARD HOSPITAL, PHILADELPHIA.

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J. ABBOTT CANTRELL, M.D.,

PROFESSOR OF DISEASES OF THE SKIN IN THE POLYCLINIC HOSPITAL AND COLLEGE FOR GRADUATES IN MEDICINE; PHYSICIAN FOR SKIN DISEASES TO THE SOUTHERN DISPENSARY, PHILADELPHIA.

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SAMUEL ASHHURST, M.D.,

SURGEON TO THE CHILDREN'S HOSPITAL, PHILADELPHIA.

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LOUIS McLANE TIFF NY, M.D.,

PROFESSOR OF SURGERY IN THE UNIVERSITY OF MARYLAND, BALTIMORE.

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JOHN A. WYETH, M.D.,

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CHARLES B. NANCREDE, A.M., M.D.,

PROFESSOR OF SURGERY AND OF CLINICAL SURGERY IN THE UNIVERSITY OF MICHIGAN; EMERITUS PROFESSOR OF GENERAL AND ORTHOPÆDIC SURGERY IN THE PHILADELPHIA POLYCLINIC, ETC.

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JOHN B. DEAVER, M.D.,

ASSISTANT PROFESSOR OF APPLIED ANATOMY IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PHILADELPHIA HOSPITAL, TO THE GERMAN HOSPITAL, TO ST. AGNES'S HOSPITAL, ETC., PHILADELPHIA.

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By

CHARLES B. NANCREDE, A.M., M.D.,

PROFESSOR OF SURGERY AND OF CLINICAL SURGERY IN THE UNIVERSITY OF MICHIGAN; PROFESSOR EMERITUS OF GENERAL AND ORTHOPÆDIC SURGERY IN THE PHILADELPHIA POLYCLINIC, ETC.

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JOHN H. PACKARD, M.D.,

SURGEON TO THE PENNSYLVANIA HOSPITAL AND TO ST. JOSEPH'S HOSPITAL, PHILADELPHIA.

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CHARLES W. DULLES, M.D.,

LECTURER ON THE HISTORY OF MEDICINE IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE RUSH HOSPITAL; SURGEON FOR OUT-PATIENTS TO THE PRESBYTERIAN HOSPITAL, PHILADELPHIA.

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EDMUND ANDREWS, M.D., LL.D.,

PROFESSOR OF CLINICAL SURGERY IN THE CHICAGO MEDICAL COLLEGE; SURGEON-IN-CHIEF TO MERCY HOSPITAL, CHICAGO.

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By

ROBERT W. LOVETT, M.D.,

ASSISTANT SURGEON TO THE CHILDREN'S HOSPITAL, OUT-PATIENT SURGEON TO THE BOSTON CITY HOSPITAL, AND SURGEON TO THE INFANTS' HOSPITAL, BOSTON.

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JOHN ASHHURST, Jr., M.D.,

BARTON PROFESSOR OF SURGERY AND PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PENNSYLVANIA HOSPITAL, PHILADELPHIA.

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DE FOREST WILLARD, M.D.,

CLINICAL PROFESSOR OF ORTHOPÆDIC SURGERY IN THE HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PRESBYTERIAN HOSPITAL, PHILADELPHIA.

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CHARLES B. NANCREDE, A.M., M.D.,

PROFESSOR OF SURGERY AND OF CLINICAL SURGERY IN THE UNIVERSITY OF MICHIGAN; EMERITUS PROFESSOR OF GENERAL AND ORTHOPÆDIC SURGERY IN THE PHILADELPHIA POLYCLINIC, ETC.

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W. W. KEEN, M.D., LL.D.,

PROFESSOR OF THE PRINCIPLES OF SURGERY AND OF CLINICAL SURGERY IN THE JEFFERSON MEDICAL COLLEGE; SURGEON TO THE JEFFERSON MEDICAL COLLEGE HOSPITAL AND TO THE ORTHOPÆDIC HOSPITAL AND INFIRMARY FOR NERVOUS DISEASES, ETC.

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LEWIS A. STIMSON, M.D.,

PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF THE CITY OF NEW YORK.

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DE FOREST WILLARD, M.D.,

CLINICAL PROFESSOR OF ORTHOPÆDIC SURGERY IN THE HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PRESBYTERIAN HOSPITAL, PHILADELPHIA.

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CHARLES W. KOLLOCK, M.D.,

LECTURER ON DISEASES OF THE EYE AND EAR IN THE CHARLESTON MEDICAL SCHOOL AND OPHTHALMIC SURGEON TO THE CHARLESTON CITY HOSPITAL AND SHIRRAS DISPENSARY, CHARLESTON, SOUTH CAROLINA.

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RALPH W. SEISS, M.D.,

PROFESSOR OF OTOLOGY IN THE PHILADELPHIA POLYCLINIC.

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JOHN B. ROBERTS, A.M., M.D.,

PROFESSOR OF SURGERY IN THE PHILADELPHIA POLYCLINIC AND IN THE WOMAN'S MEDICAL COLLEGE OF PENNSYLVANIA; SURGEON TO THE METHODIST HOSPITAL OF PHILADELPHIA.

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J. EWING MEARS, M.D.,

PROFESSOR OF ANATOMY AND CLINICAL SURGERY IN THE PENNSYLVANIA COLLEGE OF DENTAL SURGERY; GYNÆCOLOGIST TO THE JEFFERSON MEDICAL COLLEGE HOSPITAL; SURGEON TO ST. AGNES'S HOSPITAL; EX-PRESIDENT OF THE AMERICAN SURGICAL ASSOCIATION, ETC.

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JOSEPH RANSOHOFF, M.D., F.R.C.S. Eng.,

PROFESSOR OF ANATOMY AND CLINICAL SURGERY IN THE MEDICAL COLLEGE OF OHIO; SURGEON TO THE CINCINNATI HOSPITAL AND TO THE GOOD SAMARITAN HOSPITAL, CINCINNATI.

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HENRY R. WHARTON, M.D.,

DEMONSTRATOR OF SURGERY IN THE UNIVERSITY OF PENNSYLVANIA, SURGEON TO THE PRESBYTERIAN, METHODIST, AND CHILDREN'S HOSPITALS; ASSISTANT SURGEON TO THE UNIVERSITY HOSPITAL, ETC., PHILADELPHIA.

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RICHARD H. HARTE, M.D.,

DEMONSTRATOR OF OSTEOLOGY IN THE UNIVERSITY OF PENNSYLVANIA, SURGEON TO THE PENNSYLVANIA HOSPITAL AND TO THE EPISCOPAL HOSPITAL, CONSULTING SURGEON TO ST. MARY'S HOSPITAL AND TO ST. TIMOTHY'S HOSPITAL, PHILADELPHIA.

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MAURICE H. RICHARDSON, M.D.

VISITING SURGEON TO THE MASSACHUSETTS GENERAL HOSPITAL; ASSISTANT PROFESSOR OF ANATOMY, HARVARD MEDICAL SCHOOL.

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ALBERT VANDER VEER, A.M., M.D., PH.D.,

PROFESSOR OF DIDACTIC, ABDOMINAL, AND CLINICAL SURGERY IN THE ALBANY MEDICAL COLLEGE; SURGEON TO THE ALBANY HOSPITAL, ETC.

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OF NEW YORK.

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By

JOHN ASHHURST, Jr., M.D.,

BARTON PROFESSOR OF SURGERY AND PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PENNSYLVANIA HOSPITAL, ETC.

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CHARLES B. KELSEY, A.M., M.D.,

PROFESSOR OF DISEASES OF THE RECTUM IN THE NEW YORK POST-GRADUATE MEDICAL SCHOOL AND HOSPITAL; LATE PROFESSOR OF DISEASES OF THE RECTUM IN THE UNIVERSITY OF VERMONT, ETC.

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HUNTER McGUIRE, M.D., LL.D.,

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E. L. KEYES, A.M., M.D.,

OF NEW YORK.

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THOMAS R. NEILSON, M.D.,

PROFESSOR OF GENITO-URINARY SURGERY IN THE PHILADELPHIA POLYCLINIC; SURGEON TO THE EPISCOPAL HOSPITAL AND TO ST. CHRISTOPHER'S HOSPITAL, PHILADELPHIA.

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surgeon to the German Hospital and to St. Joseph's Hospital, Philadelphia.

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CHARLES B. PENROSE, M.D.,

PROFESSOR OF GYNÆCOLOGY IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE GYNÆCEAN HOSPITAL, PHILADELPHIA.

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ROBERT P. HARRIS, A.M., M.D.,

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THEOPHILUS PARVIN, M.D., LL.D.,

PROFESSOR OF OBSTETRICS AND DISEASES OF WOMEN AND CHILDREN IN THE JEFFERSON MEDICAL COLLEGE, PHILADELPHIA.

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EDWARD COWLES, M.D.,

SUPERINTENDENT OF THE McLEAN HOSPITAL, WAVERLEY, MASS.

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THE INTERNATIONAL ENCYCLOPÆDIA OF SURGERY.

INFLAMMATION.

BY

HAROLD C. ERNST, A.M., M.D.,

ASSISTANT PROFESSOR OF BACTERIOLOGY IN HARVARD UNIVERSITY; PHYSICIAN TO OUT-PATIENTS AT THE MASSACHUSETTS GENERAL HOSPITAL, ETC.

BOTH the pathology of inflammation and its clinical aspects have been so fully treated of in the two articles already devoted to these subjects in the first volume of this work, that a reconsideration of the topics there discussed at length would be an undesirable filling of space to no good end. There remains to speak of the recent advances in the knowledge of the subject, which seem likely to revolutionize at least a part of the theories held in regard to the changes seen, and which have not been fully touched upon in the articles spoken of. These advances lie in the increase of our observations upon the etiology of the processes commonly grouped under the heading of inflammation, and depend largely and especially upon the work of one individual, whose researches are as epoch-making as those of Virchow or of Cohnheim.

The researches spoken of are those of Metchnikoff and his followers, and these, taken together with the general increase of knowledge of etiology in the last few years, enable a new point of view to be taken in regard to inflammation, which it now seems necessary to look upon as a *symptom* of some disturbance of the tissues, and not in any sense as a disease by itself. This is the position that will be taken in regard to it—that it is a *symptom of irritation of some sort*—and this being well understood, the keynote of what follows will easily be found.

The recent advances in our knowledge of bacteria have completely changed our ideas in regard to the process. Up to the time of these advances, it had been taught that inflammation was the result of a local irritant, producing an excessive flowing of blood to the part, with

vascular paralysis and exudation; that it might be produced by a foreign body, such as a splinter of wood, or that it might be due to a poison in the blood, and the activity of the bacteria in producing the condition was not only ignored, but was unknown. With the advance of our knowledge, has gradually come the belief that practically all forms of true inflammation are the result of the activity of bacteria, and this belief has gone so far as to permit Gerster[1] to make the assertion, which, however, is not quite correct, that bacteria are necessary for the production of all inflammations. His position is stated as follows:—

"An injury of some kind has devitalized the tissues of a certain region, and these become a living pabulum for micrococci. The living tissues around still form a decided resistance to the invasion of the microbe. Bacteria cannot thrive on the products of decomposition. They need for their sustenance dead, but undecomposed, albuminoid substances. As soon as the supply of dead animal tissue is exhausted, the micro-organisms starve and perish, while the spores are left behind dormant. We will suppose the injury resulting in the inflammation to have been a wound. This has destroyed the vitality of those cells that lie in the direct path of the cutting implement. The blood and lymph exuded from the vessels have coagulated, and also the dead matter. If a number of micrococci are implanted in the bottom of the wound, they are at once multiplied, using the blood clot and its extensions into the blood-vessels, together with the adjacent dead or devitalized tissues, as welcome soil for their development. This fermentative decomposition produces, from the very beginning, certain poisonous alkaloids—ptomaines—that are very diffusible. These have a toxic influence on the adjacent vaso-motor nerves, causing their paralytic dilatation, hence the active hyperæmia, the *rubor*. The blood passing through the adjacent arterioles and capillaries seems also to become altered, the red corpuscles become packed, and finally stagnate in the smaller vessels. The walls of these vessels, including the veins, lose their impermeability, and there is emigration of the leucocytes, and even of the red corpuscles, into the surrounding tissues, hence the swelling, *turgor*. Chiefly as a consequence of the increased blood supply, a marked increase of the local temperature is observed, *calor*. Direct pressure, caused by the dense inflammation, and the actual destruction of the nerve tissue, perhaps also in some measure the immediate influence of the ptomaines on the sensory nerve filaments of the part, give rise to pain, the *dolor*. Stagnation and dense infiltration finally produce a very high degree of tension, leading to compression of large afferent vessels. The inflamed portions, devitalized by suppression of the animal circulation, readily succumb to the inroads of the millions of micro-organisms, and actual necrosis rapidly follows. The last stage of textural destruction is the final liquefaction of the tissues and infiltrating leucocytes, aided by the exudation of large quantities of lymph serum from the adjacent unobstructed blood-vessels, and thus we have the formation of an abscess, or a cavity, filled with lymph serum, dead leucocytes (pus cells), and shreds of necrosed tissue. The veins also participate in the disturbance, and give actually of their contents; *thrombosis* takes place, and adds to the existing stagnation."

Here we have stated very briefly the usual processes seen in what is called inflammation, together with the old cardinal points that have always been considered as going to make up the clinical picture to which the name is given. A better statement even than this, and perhaps the best in any of the recent monographs upon the subject, is that which is to be found in "An American Text-Book of Surgery" (Philadelphia, 1892), in which it is stated that "inflammation is a dis-

[1] Aseptic and Antiseptic Surgery, 1888.

turbance of the mechanism of nutrition, and affects the structures concerned in this function."

From the point of view of this article, as will be seen, this is not quite the idea that it is desired to convey, and instead of saying that inflammation is "the response of living tissue to injury," we are inclined to say that it is the response of living tissue to irritation, as a result of the disturbances occurring in connection with this irritation, of whatever kind it may be. Various changes give rise to the five cardinal symptoms of inflammation, pain, heat, redness, swelling, and impaired function (*dolor*, *calor*, *rubor*, *tumor*, *functio læsa*).

Changes in the Blood-Vessels.

The changes to be seen in the blood-vessels are the first that attract attention, and our knowledge of these changes is very largely due to the work of Cohnheim in 1867. Recklinghausen was the first to show that many connective-tissue cells possess a power of motion and migrate into the inflamed part, forming a portion of the great number of cells found there, and Cohnheim identified the cells of inflamed tissue with the white blood corpuscles or leucocytes. The beginning of an inflammatory process is marked by a greatly increased rapidity of the flow of blood in the part, producing *hyperæmia*, and this is followed by a slowing of the current. A great accumulation of white corpuscles takes place on the interior of the vessel wall, and this is followed by an emigration of these leucocytes from the interior of the veins, producing *diapedesis*.[1] The leucocytes escape through the walls by sending out little prolongations (*pseudopodia*) that extend through the wall of the vessel, and the remainder of the corpuscle follows, but the question of the existence of actual spaces, or holes, in the wall of the vessel, through which the cells may pass, is as yet a disputed one. No such process of migration has been seen occurring through the walls of arteries, nor, excepting to a limited extent, through the walls of the capillaries. The changes thus seen in the circulation in inflammation explain two of the main symptoms, the *heat* and the *redness*. The *swelling* is to be accounted for by the alteration of the tissues of the part, which are found distended with an abundant exudation, escaping through the walls of the dilated blood-vessels, consisting not only of leucocytes, but also of a certain amount of fluid closely resembling the liquor sanguinis. It was at first supposed by Cohnheim that all the cells found in the part came from the white blood corpuscles, but later investigations have shown that the fixed connective-tissue corpuscles and other cells in the tissues of the body are capable of division, and by the latest views the multinuclear leucocytes appear to be taken up and destroyed by the proliferating connective-tissue cells, the leucocytes apparently serving simply as nutrition for these. The function of leucocytes has been widely argued. Cohnheim considered them to be active agents during repair, and Metchnikoff has advanced the important theory of *phagocytosis*, to which much space is given in this article. The *pain* felt in inflammation is due to pressure or tension produced by the swelling upon the terminal branches of the nerves, and it may also

[1] See Stricker's article on Inflammation, in Vol. I

be due to increased sensibility from hyperæmia, and to the chemical irritation resulting from the presence of ptomaines. The fifth symptom of inflammation, the *disturbance of function*, manifests itself in various ways according to the part affected. It is now a well acknowledged fact that inflammation does not begin spontaneously, and the idiopathic form of inflammation recognized by older writers is now not believed to occur.

Theories of Inflammation.

The pathology of inflammation from one point of view is also very well summarized in an editorial in the Boston Medical and Surgical Journal (1892), in which the views of Cohnheim are especially emphasized. He considers, in his lectures on General Pathology, the numerous theories that have been adopted to explain inflammation.

The *neuro-humoral* theory has had many advocates, being presented in two modified forms, an *ischæmic* and a *paralytic*. According to the former, it is to the contraction of the afferent vessels of a part, reflexly called forth by the excitation of sensory nerves, that the slowing of the capillary stream is due. According to the second, it is a reflex relaxation and dilatation of the arteries that occasions the inflammatory hyperæmia. Narrowing of the arteries, according to Cohnheim, can only produce anæmia, or extreme necrosis, and active hyperæmia can only exceptionally produce exudation. It has been shown, besides, that parts unconnected with the remainder of the body, except by means of their principal vessels, may undergo inflammation, as in the frog the tongue may become inflamed, even when the brain and medulla oblongata are completely destroyed.

The *cellular theory* of inflammation presupposes an attraction of the tissues, or tissue cells, and the vessels and their contents. The tissue cells swell and enlarge, and give birth to new cells, the pus cells; an influence that Cohnheim thinks could only relate to fluids. But how the tissue cells can bring colorless or red corpuscles out of the vessels is not easily to be understood, and it can also be shown in many instances that not only a very marked hyperæmia is present, but also very considerable transudation before the slightest change has occurred in the tissue cells.

If then inflammation begins neither in the nerve cells nor in the anatomical elements of the part, it seems to bring us to the fundamental conception of inflammation according to Cohnheim, that it is the *excitation and consequence of a molecular alteration in the vessel walls*. By this alteration, adhesion between the vessel wall and the blood, and by consequence friction, is increased, the result being the retardation of the blood stream in the inflamed district, while the permeability, the porousness of the walls, is augmented by the molecular change, and this results in an increase of transudation of the albuminous contents, as well as in the admixture of colorless and red corpuscles with the transuded fluid. He does not consider that the exit of the leucocytes depends upon spontaneous movements, but that it is a mere process of mechanical filtration. He considers the causes of inflammation to be every agency by which the chemical construc-

tion of the vessel walls is at all altered, and which, on the other hand, is not so powerful as to bring about the death of the vessels, and these causes may be classed under three principal heads as *traumatic*, *toxic*, and *infective*. The point that especially distinguishes inflammation from active or passive hyperæmia is certainly the *exudation*. What is especially owed to Cohnheim is the demonstration that it is only the vessel wall which is responsible for the whole series of events in inflammation. He considers it evident that this is not due to an action on the blood, because the blood is constantly in motion, and can never be more than momentarily exposed to the local action; and the vasomotor nerves may also be excluded, since the fact that the vessels are wont under the influence of various agents to dilate very much more than is ever the case in paralysis of the vaso-constrictors, or in hyperæsthesia of the vaso-dilators, seems to weigh against their taking part in the process. Besides, all the described effects set in in precisely the same way, and with equal prominence, in parts deprived of all connection with the central system. Finally, it is not an action or reaction of the tissues surrounding the vessels, for no alterations are observed in the latter, except at most such as are of a deleterious character, as for example, coagulation or rupture of the muscle fibres. "We are therefore compelled by exclusion to come back to the vessel walls, as the central originating focus. According to this view, therefore, we have had to deal with a molecular change of the vessel walls, whose highest degree involves the death of the latter, but whose slighter degrees, on the other hand, call forth a certain typical series of abnormal events in connection with the motion of the blood and the transudation. The sum total of these events, together with their consequences, have been for ages comprised and known under the name of inflammation."

Causes of Inflammation.

Notwithstanding the fact that in Prof. Van Buren's article in Vol. I., the causes and definitions of inflammation, as they are usually thought of, are very fully considered; and also notwithstanding the fact that in the present article inflammation is considered from a different point of view from the usual one, a brief summary of the commonly described causes will not be out of place here. Considering inflammation, therefore, as merely a symptom of the effect of some preceding agent, its causes may be looked upon as arising from (1) mechanical violence; (2) irritant or destructive chemical action; (3) poisonous infection, including, besides bacterial action, such things as venom of serpents, etc. There are, of course, both *predisposing* and *exciting* causes aiding the appearance of inflammation, and among the first, we may include a defective nerve supply, the period of life, and the habit of body and climate. Among the second, *the exciting causes*, there is, as Van Buren says, strictly speaking but one cause, and that is an irritation of the living tissues by some agent that is called an irritant. But these irritants are necessarily very numerous, and among them must be included cold, or sudden chilling of the body (although it is doubtful by the light of our newer knowledge whether this is not one of the predisposing causes, and not a true ex-

citing cause), incised wounds, punctured wounds with rough instruments, the presence of foreign bodies in wounds, mechanical violence, contusion of living tissues, the presence of a clot of blood in a wound, slight persistent mechanical irritation, the effects of heat and certain minerals, the poisonous action of secretions of animals, and last, but most important, the action of bacteria or their products. It is one result of the later experimental science that there appears to be ground for the belief in the possibility that most of these exciting causes, certainly as their results are seen in practice, are not true exciting causes at all, but must be placed among the predisposing causes; as, for example, in such a case as is quoted by Van Buren, as follows:[1]—

"A gentleman of 28, in full health, stripped himself entirely on returning home from business on an exceptionally hot day, and threw himself on a lounge before an open window, to cool off before dressing for dinner. He fell asleep, heedless of a thunder-storm accompanied by a decided fall in the temperature, and awoke thoroughly chilled. On the same night he was seized with a rigor, which proved to be the initial symptom of an acute general peritonitis which terminated fatally within a week."

In such a case as this, it is hardly fair to ascribe the inflammation to the effect of cold, pure and simple, for if its etiology be the same as in all other cases of peritonitis that have been investigated by proper bacteriological methods, the peritonitis was produced by the activity of a definite form of bacterium, and the chilling acted merely as a predisposing cause, probably diminishing the chemiotactic power of the corpuscles of the body.

The mass of evidence that has been collected of late years, favoring the belief that active forms of inflammation and suppuration are due to bacterial activity, hardly warrants the conclusion reached by Sternberg,[2] that the inference that no pus formation can occur in the absence of micro-organisms of this class (those found in acute abscess) is a mistaken one, and that certain chemical substances introduced beneath the skin give rise to pus formation quite independently of bacteria. It is true that among the substances tested, which have given a positive result, are nitrate of silver, oil of turpentine, strong liquor ammoniæ, cadaverine, etc., and that the demonstration has always been made, apparently, that cultures of pus cocci when sterilized by heat still give rise to pus formation, when injected subcutaneously. In regard to this subject I must hold to the position expressed some years ago, when, in a discussion upon the conditions underlying the infection of wounds,[3] I made the following statements, first quoting the conclusions of an article read before the American Surgical Association several years before:—

As far as the experiments go, they tend to show that no form of the suppurative process in man is unattended by the presence of bacteria. . . . This conclusion, that of the dependence of the suppurative process upon bacteria, is very strongly supported by the most recent evidence of the best-equipped workers in the field of bacteriological research. This assertion indeed does not need to be very considerably modified even now, although, in the face of such work as can be quoted, it cannot be said that actually no suppuration, or at

[1] Vol. I., page 73. [2] Manual of Bacteriology, page 263.
[3] Transactions of the Congress of American Physicians and Surgeons, vol. ii., page 71, 1891.

least a process answering all the histological requirements of that expression, occurs without the action of bacteria. The experiments spoken of make it impossible to doubt that such processes as they speak of may occur, although it is not yet proved that these processes should be included under the head of true suppuration. It is an *experimental* suppuration, perhaps, but as far as is apparent it differs entirely from the processes observed in man. Experimental suppuration produced by chemical action is localized, and never spreads from the place of origin; there is never any metastasis, the amount is directly in proportion to the amount of the irritating agent made use of, and the products of this form of suppuration never produce new activity when introduced into other animals—characteristics differing very markedly from what is known of true bacterial, or, as may be said, of *human* suppuration. If one were obliged to sum up the present position of affairs, it would be something like this: notwithstanding the laboratory experiments to show the possible occurrence of chemical suppuration, it still remains to be demonstrated that the infection of wounds as seen in practice occurs without the influence of bacterial activity. The numbers and varieties of bacteria thus occurring are well shown by the summaries of Zuckermann and Karlinsky. This being true, such researches as those of Ullmann and Welch, showing where these bacteria are most commonly found, are of special value. The most important lessons yet taught to us are those which warn us that our pupilage is not yet over, and that we are but entering upon the first stage of our knowledge of the processes spoken of here to-day.

This position in regard to the effect of bacteria upon wounds may be held and defended in regard to most forms of inflammation that come under observation. The processes that must be excluded from those produced by bacteria form a class by themselves, and should be considered under a separate group, and here it is interesting to quote some of the conclusions of Park [1] upon wound infection. In closing, he says that the particular features to which he would especially invite attention may be epitomized in the following conclusions:—

Sepsis may arise from circumstances and conditions other than those pertaining to the wound itself, although hitherto practitioners have been too prone to scan solely this field in searching for its cause. Sepsis and infection are combated in more than one way by natural agencies and by inherent properties of cells and fluids, totally aside from the measures which the surgeon institutes. A recognition of the power of chemiotaxis possessed by organized and unorganized materials in such varying degree, can be utilized to great advantage, as soon as it can be reasonably clearly defined.

Welch also may be quoted in the same direction from his article upon "Conditions Underlying the Infection of Wounds," [2] in which some of the conclusions reached are as follows:—

"The number of different species of bacteria, particularly of bacilli, revealed by the systematic study of traumatic infections, is much greater than was formerly supposed; the pyogenic staphylococci and streptococci, however, are by far the most common causes of suppurative affections of wounds. A coccus, which may appropriately be called the *Staphylococcus Epidermidis Albus*, is a nearly, if not quite, constant inhabitant of the epidermis, lying both superficially and also deeper than can be reached by present methods of disinfection of the skin. . . . It is the most common cause of stitch abscesses in wounds treated antiseptically or aseptically. The pathogenic bacteria set up suppuration by means of chemical substances produced by them, and entering into their com-

[1] Transactions of the Congress of American Physicians and Surgeons, vol. ii., page 49.
[2] Ibid., page 27.

position. The studies of chemiotaxis have shed much light upon the mode of action of these substances. The tissues of the wound should be handled so as to interfere as little as possible with their vital capacity to overcome bacteria."

In the preceding passages and quotations, I have endeavored to state as clearly as possible such modifications of and additions to the views in regard to inflammation taken in the articles by Stricker and Van Buren, as seemed to be necessary in the light of the newer researches upon the subject.

Immunity and Phagocytosis.

Closely allied is the doctrine of *immunity and phagocytosis*, as furnishing a possible explanation of many of the phenomena seen in the processes under discussion, and without a somewhat full explanation of the present position of pathology in regard to these, it will not be possible to understand their full significance. I am convinced that the doctrine of phagocytosis and the work of Metchnikoff in connection with it, have not received the recognition that they really deserve, and even if the doctrine be not so wide-sweeping in its applicability as this author feels, nevertheless its value is very great.

William Hunter,[1] speaking of phagocytosis and immunity, comes to the following conclusions as expressing the chief grounds upon which he considers that the doctrine claims a greater credence than has been given to it by the school which has Klein at its head:—

He is disposed to claim for it, that in revealing the power possessed by the cells of themselves opposing the attacks of virulent bacteria, it has not only added much that is new, but is also valuable and important as explaining the means by which infectious disease is combated; and that our knowledge of the bactericidal properties of blood serum, to which so much importance is attached by the opponents of the phagocytic theory, is itself the direct outcome of the attention drawn by Metchnikoff to the action of cells. So far from being antagonistic, the two doctrines, the phagocytic and the humoral, mutually supplement and support each other. Both theories recognize the existence of antitoxic and antibiotic substances in blood serum and blood plasma, but it is, in Hunter's opinion, the peculiar merit of the phagocytic as opposed to the humoral doctrine, that it subordinates their interest and importance to the action of the cells from which they admittedly derive their origin. He is disposed to claim for the phagocytic theory, that, while it does not profess, as its opponents assert, to be in any way a complete or satisfactory explanation of the phenomena of immunity, yet as a working hypothesis, and it is that which we must first look for, it is in all respects more logical, more tenable, more in consonance with the teachings of cellular pathology, and almost more biological, than that which ascribes to the fluids of the body the first *rôle* in protecting it against infectious disease.

Considered apart from the teachings of phagocytosis, the humoral doctrine has as its chief characteristic, in Hunter's opinion, a self-satisfying sufficiency, for which there is no real basis. It appears to explain, without explaining. It speaks much of antibiotic and antitoxic substances in the fluids of the body, and is apparently content to rest there. It does not ignore their origin from cells, indeed cannot possibly do so, but, unlike the doctrine of phagocytosis, it does not encourage further inquiry into the nature of the changes of cells

[1] British Medical Journal, 1892.

which lead to the production of these substances, or into the conditions which determine the precise reaction in the cells necessary for their formation. In the first instance, on both views, the final nature of the change, whether in cell or in product, is unknown; but as the change in the cell must necessarily precede that in the product, and as the doctrine of phagocytosis directs most attention to the cells, that doctrine has claims on our support out of proportion greater than any teaching that may temporarily draw our attention away from the cell to the product in which it lies, and thus exalt the product at the expense of the producer; and lastly it is claimed for the phagocytic theory that in attaching special importance to the action of certain cells—leucocytes of the blood, cells of the spleen, and lymphocytes generally—it draws attention to facts of wide physiological importance, namely, that it is precisely these cells that govern in a special degree the constitution of the plasma and blood serum; and that therefore, whether acquired immunity be due to a direct phagocytic action of these cells, or to antibiotic or antitoxic properties of the plasma of the blood, the cells must be specially affected by the preceding changes.

This is a very fair statement of the position that must reasonably be taken in regard to the subject; but for a clear knowledge of what it is, recourse must be had to the work of Metchnikoff himself, and this is nowhere so well stated as in his Lectures upon the Comparative Pathology of Inflammation, delivered at the "Institut Pasteur" in April and May, 1891 (Paris, 1892). In this volume he details the most important and remarkable studies upon inflammation which have appeared since the publication of Virchow's Cellular Pathology and Cohnheim's great work upon the Inflammatory Processes. "His theories of inflammation," says Steven, "differ from all others with which we are acquainted, and this being so, they must be subjected to the most searching criticism before they can be accepted in whole or in part. They are founded upon an exhaustive and conscientious investigation of biological phenomena, in so far as these bear upon this most interesting and complicated pathological process."[1]

Toward the end of the first lecture, the basis of all modern ideas in regard to inflammation is stated, when it is said that instead of placing the phenomena of inflammation in two fundamentally distinct categories, regeneration and degeneration, injury and repair, they must all of them be regarded as a healthful reaction against some sort of disturbing cause. Metchnikoff shows that comparative pathology, by taking recognition of the phenomena seen in the lower invertebrates, may give information that research in the vertebrates cannot supply, on account of the presence in these latter of disturbing elements. Indeed, heretofore, it has only been possible under experimentation to eliminate one of the factors of inflammation—that of a rise of temperature—and this has been done in the frog because it is a cold-blooded animal and incapable of producing heat in any appreciable quantity. We must employ invertebrate animals in order still further to eliminate certain of the factors present in the process, and it is in this way only that we can ever look to be able to answer the following questions: Can the factors of traumatism, or infection, that produce inflammatory changes in the higher animals, produce anything analogous in the inferior vertebrates, such as the amphioxus; or in the invertebrates is the presence of a circulatory system indispensable to the production of inflamma-

[1] Glasgow Medical Journal, Sept. 1, 1892.

tion; or *can it also be produced in animals which have no blood-vessels?* What is the part played by the nervous system? In regard to the production of inflammation, is it necessary that an animal should possess a series of differentiated organs, or is it sufficient that it should be composed of an accumulation of non-differentiated corpuscles? Can anything analogous to inflammation be found in the vegetable kingdom? Do unicellular organisms present inflammatory phenomena? These are the questions that Metchnikoff has endeavored to answer in the lectures which detail the methods that he has pursued in arriving at his conclusions.

Steven[1] pursues the argument about as follows: Starting with the general principle that the most marked characteristics, both of plant and animal organisms, are those adapting them either for aggression or defence, and that active aggression is easily transformed into infection, and that defence from this point of view is equivalent to the salutary reaction of the organism against infection, all the phenomena observed by Metchnikoff or others in the invertebrates and lower vertebrates, which have any bearings upon the explanation of the inflammatory process, are described. We are told that the amœbæ and the infusoria react to traumatism or infection, and that amœbæ are liable to epidemics of infectious disease communicated by other minute organisms attacking them. We are shown the effects produced upon bacteria when taken into the bodies of amœbæ. They absorb vesuvine there, although it has no effect upon them outside, and these results are said to be produced by the digestive action of the amœbæ called forth for their self-defence. In the case of paramœcium, organisms capable of thriving vigorously are digested and rejected in the protoplasm of the organism itself. Going on to the polycellular organisms, the phenomena observed that affect large protoplasmic masses, to which the term "plasmode" is applied, are first of all described in detail. It is shown that the currents observed in this undifferentiated living mass may flow toward, or be directed away from, external agents, according as they are beneficial to or destructive of the protoplasm. The effect of traumatic, physical, and chemical irritation are considered in detail, and the significance of the property of chemiotaxis, positive if protoplasm be attracted, negative if it be repelled by the external agent, is indicated, especially as regards the important bearing it has in explaining the behavior of corpuscles in the higher animals during the inflammatory process. It has been shown that the chemiotaxy of these inferior beings obeys Weber's law for the sensitive perceptions of mankind, and it also appears that they can become acclimatized to their surroundings.

The production of cicatrices in plants, as the result of traumatism, and the bearing of this upon Virchow's theory of inflammation as a nutritive and formative hyperplasia of the inflamed tissues, are discussed. Metchnikoff does not consider that this phenomenon lends any great support to Virchow's opinion, for the reason that no account is taken of the phenomena, even more characteristic of inflammation, which are exhibited by organisms intermediate between plants and higher animals. Plants are protected from the attacks of bacteria by the thick resisting cell membranes, but, on the other hand, they are

[1] Loc. cit.

especially liable to invasion by moulds, which possess a great power of growth, and secrete a diastase which dissolves the cellular membrane of the plant. If the mould obtains entrance, it absorbs the cell contents without hindrance, and the cells invaded perish, or, if they survive, undergo hypertrophy, often giving rise to the formation of special tumors or "galls," and sometimes even to a hypertrophy of the whole organism. As in the cure of wounds, infections in plants are accompanied by regenerative phenomena, due to the abundant multiplication of corpuscles not directly attacked, without presenting a process comparable to the essential conditions of inflammation. To arrive at these, it is necessary to examine the conditions met with in the animal kingdom.

In thus drawing a hard and fast distinction between proliferative or regenerative phenomena and the "essential acts of inflammation," the author is promulgating an opinion [1] which is not unlikely to call forth a good deal of adverse criticism. Calling attention to the fact that we do not know how polycellular animals are derived from the protozoa, that this gap must be filled by theories based on embryological observations, and indicating the subject of his own theory upon this question, to which he has given the name of *phagocytella*—the stage phagocytella being easily transformed into the stage gastrula—an account is next given of the experiments upon sponges. He points out the different parts played by the contractile and sensitive cells of the ectoderm, and by the mobile amœboid corpuscles (phagocytes) of the mesoderm, in the protection of the organism from noxious external agencies. The flagellate cells of the entoderm are also endowed with the powers of phagocytes, as they surround small granules carried to them by the currents of water passing into the sponge, but the chief power in this way is located in the mesodermic cells and the contractile cells of the ectoderm, while the power of preventing to a certain extent the passage of noxious matters is effected also by closing the superficial spores. In similar detail, the phenomena bearing on the inflammatory process in the higher members of the invertebrate group, such as the cœlenterates, worms, molluscs, etc., are described. In the case of those species supplied with a vascular system, it is shown that the blood-vessels take no part in the reactionary process (phagocytosis) that Metchnikoff believes to be the essential element in inflammatory action.

As we ascend higher in the scale of animal existence, it is interesting to note how the phagocytes become specialized and located in different parts of the economy. In the case of worms, it is shown that the mesodermic phagocytes are represented by the cells suspended in the perivisceral liquid, or by the endothelial cells of the peritoneum, and in this case, the struggle between the parasite and the phagocytes goes on; while the blood-vessels developed to a high degree in the annelida remain completely inactive, presenting neither visible changes of volume nor secretion of the reddish colored plasma. Among the invertebrates are found leucocytes with phagocytic properties presenting different characters—some granular, some hyaline, all possessing a large, oval, non-lobulated nucleus. In invertebrate animals whose vascular system is not entirely shut off from the general body cavity, we do not find polynuclear leucocytes (arthropodes and mol-

[1] Steven, loc. cit.

luscs). Inflammatory reaction may be induced, and abundant leucocyte accumulation accompanied by giant-cell formation take place, without any question of diapedesis, for the simple reason that the vascular system is not completely closed, and is in communication with the body cavity.

There are recorded a number of observations of inflammatory infections in some of the lowest vertebrates and their embryos, and it is shown that it is possible for these to be excited without the interference of the vascular system. Metchnikoff recapitulates the whole series of phenomena observed, and their details, in the first seven lectures, pointing out that in the *vegetable* kingdom, although there may be lesions such as primary necrosis and regeneration, yet there is no inflammation. This process appears only in the *animal* kingdom, commencing in those organisms that are endowed with a mesoderm. There is given a detailed description of the different varieties of leucocytes, of which there are four principal kinds: first, the small lymphatic corpuscles (lymphocytes) formed by the lymphatic glands, containing one nucleus surrounded by a thin layer of protoplasm; second, mononuclear leucocytes, having a single oval or rounded nucleus, and bearing a slight resemblance to certain fixed elements of the connective tissue; third, Ehrlich's eosinophilic corpuscles, which contain often lobulated and variously shaped nuclei, and which stain best with acid aniline colors; and fourth, multinucleated corpuscles, which, in reality possessing only a single nucleus, often have the appearance of a clover leaf or a daisy, the different lobes being united by thin filaments. The first two varieties of leucocyte merge the one into the other, and the fourth variety is often denominated a "*leucocyte neutrophile*," because it is only possible to stain both the nucleus and the protoplasm by a mixture of acid and basic aniline colors. These corpuscles develop in the lymphatic glands, the spleen, the bone marrow, and the blood, the last named being the part in which the ordinary polynuclear corpuscles chiefly originate. All the varieties are amœboid, but the lymphocytes and the eosinophilic bodies have no power of phagocytosis, a property that especially characterizes the mononuclear and polynuclear or neutrophilic bodies. Certain organisms, such as the streptococcus of erysipelas and the gonococcus, are never taken up by mononuclear corpuscles, while they are easily absorbed by the polynuclear. On the other hand, the bacillus of leprosy is never absorbed by the polynuclear corpuscles, while it is readily taken up by the mononuclear, and this difference in the reaction of the two classes of leucocytes is ascribed to "chemiotaxis."

There are next brought forward a large number of observations illustrating the chemiotactic and digestive properties of leucocytes, and it is admitted that, while it is a fact that leucocytes can digest bacteria, the agent by which this is accomplished, whether a digestive diastase or something else, is not yet known, and it is also affirmed that because in the higher animals the peptic and tryptic ferments do not destroy bacteria, there is no reason for affirming that there are not in them other ferments possessed of a bactericidal action. As regards the multiplication of leucocytes, Metchnikoff shows that while polynuclear corpuscles most often divide directly, they are also capable of reproduction by nuclear division (karyokinesis), a fact that has been shown by Flemming in the leucocytes of the salamander, and by Spronck in the leucocytes of the blood of the rabbit.

By means of observations on the fin of the tadpole, artificially inflamed, Metchnikoff has observed that in these animals polynuclear leucocytes can transform themselves by fusion of the nuclei into those of the mononuclear variety, and can indeed become veritable fixed cells of the connective tissue. On these grounds, he considers that the opinion accepted by the Berlin Congress of 1890, that leucocytes, that is, emigrated corpuscles, can play no active part in the formation of tissue, is no longer to be sustained. It is not the new view of Ziegler, but his old one of 1875 and 1876, that is correct, and in support of this assertion Metchnikoff brings forward the facts observed by himself and his pupils, that in rabbits inoculated with tubercle, epithelioid and giant cells are formed in the interior of the vessels at the expense of the mononuclear leucocytes.

In this summing up of observations upon leucocytes, it is shown that the two classes of corpuscles that play the principal part in inflammation are the mononuclear leucocytes and the "neutrophilic" cells. These are the elements endowed with a chemiotactic and physiotactic sensibility that are capable of amœboid movements, and that are able to surround and digest foreign bodies, notably the living bacteria. It is certain that, at least in amphibians, polynuclear leucocytes can transform themselves into mononuclear corpuscles, and become fixed cells of the connective tissue. In vertebrates in general, mononuclear leucocytes can be transformed into epithelioid and giant cells; and all that has been said on the subject of leucocytes applies with equal force to the different varieties of migratory corpuscles.

Metchnikoff next goes on to discuss in detail the part played by the endothelial cells of the blood-vessels, and shows that they are contractile, and that this property has much to do with the stomata that are formed in the process of diapedesis. It is also asserted that the endothelial cells can, under certain morbid conditions, quit the vessel wall in virtue of their amœboid movements, and form a kind of adventitious membrane in the interior of the vessel; and that they are also capable of taking up foreign granules and bacteria. It is admitted that the connective-tissue elements play some part in the inflammatory process, chiefly in the production of cicatricial tissue. The plasma cells of the connective tissue are leucocytes that have become immobile, and that can resume their migratory character under the stimulus of inflammation; and the "Mastzellen" of Ehrlich that abound in inflammatory products are regarded as a kind of scavengers for clearing away the detritus of other elements. The emigration of the leucocytes is considered to be determined by the chemiotactic state of the corpuscles, induced by the poisonous microbic agency employed, rather than by any condition of the vessel wall or circulating blood. The axial and the peripheral arrangement of the blood corpuscles is not looked upon as in any way due to mechanical causes, and it is asserted that Cohnheim overlooked the influence of the nervous system in the causation of inflammatory hyperæmia and diapedesis. Metchnikoff considers that the sensibility of the leucocytes plays the most weighty part in inflammatory maladies, although this does not mean that in the vertebrates endothelial sensibility, nervous influences, and other functions may not also take part in the process.

In acute inflammation, there is a vascular dilatation, an active state

of the vascular endothelium, and an exudation with diapedesis, three phenomena which result in an afflux of phagocytes toward the inflamed area. Are the same phenomena present in chronic inflammations, in which the principal *rôle* has hitherto been attributed to local changes in the tissues without any notable influence of sanguineous and vascular elements? As illustrating this question, there are studied in detail the processes involved in the formation of a miliary tubercle, as a type of chronic inflammatory change. The view of Baumgarten, which is that generally accepted, that tubercle is the product of a proliferation of fixed local elements due to the presence of the bacillus of tuberculosis, is rejected. According to this view, the leucocytes and phagocytic corpuscles play only a secondary part in the formation of tubercle; but after describing in detail the development of artificially induced tuberculosis in the liver of a rabbit, Metchnikoff's own view of the origin of tubercle is formulated as follows: "A tubercle is made up of a massing together of phagocytes of a mesodermic origin, that crowd toward the points where the bacilli are found, and englobe them. The phagocytes taking part in the formation of a tubercle are of a mononuclear character. Polynuclear phagocytes take up the bacilli very easily, but soon perish, and with their contained bacteria are destroyed by different varieties of mononuclear phagocytes that are called *macrophages*." The calcification of tubercle is looked upon as the result of an active secretion on the part of giant cells, not as a degenerative process; and in support of this view are offered the details of the effects of inoculation of the gerbille, a rodent of Algeria, which is very resistant to tuberculosis, and which defends itself in this way. It is admitted, however, that frequently the tubercular phagocytes themselves perish and become caseous. This theory of the action of the giant cell in the tubercular process is directly opposed to that supported by Koch and by Weigert, who regard the tubercular giant cell as presenting a state of partial necrosis, which view of the process is one that has been very generally accepted, and seems to be up to the present time that which is best supported.

With regard to serous inflammations, it is shown that generally the serous exudation contains very few phagocytes, and that in this respect it differs from the ordinary varieties of acute and chronic inflammatory processes. Some varieties of serous inflammation are due to the fact that there is a "negative sensibility" of the leucocytes preventing their passing along with the fluid through the inflamed vessel walls. The exuded fluid in these cases, however, contains a considerable number of bacteria that multiply without hindrance. In another class of cases, as for example diphtheria, serous exudations take place in areas more or less distant from the collections of bacteria, and in these exudations there are no bacteria. The question then arises as to the object of the serous exudation. Some experimenters look upon the process as a means of ridding the organism of its enemies, and believe that the serum possesses a bactericidal power. Metchnikoff objects very vigorously to this view, and details a number of experiments in support of his opinions. Phagocytes alone are, he thinks, the agents provided in the organism for the destruction of pathogenic bacteria, but at the same time the fact of the occurrence of serous inflammation has been difficult for him to explain, a difficulty which he meets by saying that at

present we are only incompletely acquainted with the phenomena of serous inflammation, and that from whatever point of view we look at it, it appears always as an occurrence of much less importance than true inflammation, that is to say, that which is accompanied by an accumulation of phagocytes in the inflamed area. Also from the point of view of comparative pathology, serous inflammation is regarded as of much more recent date genealogically than this "*inflammation par excellence*" which is accompanied by a "leucocytic reaction."

In the last lecture, the theories of Virchow and Cohnheim are criticised in detail. The nutritive-attraction theory of Virchow is summarily dismissed as untenable, and many facts both experimental and natural are brought forward in regard to the injured-wall theory of Cohnheim to show that it also must be rejected. Metchnikoff lays great stress upon the different effects resulting from inflammatory causes introduced into the blood stream, and from those applied outside the vascular system. In these arguments, however, he applies the term inflammation in a way that Cohnheim, and probably also most living pathologists, would not accept. It is certainly something quite new to think of an intravascular inflammation. Quoting the phenomena of recurrent fever as an illustration of this, appears to be arguing in a way that Cohnheim would never have recognized. For what we ordinarily understand by recurrent fever, and the poisoning of the blood that takes place in consequence of the presence there of the organisms which cause it, is something very different from inflammation as ordinarily understood by the morbid anatomist and the clinician. If Metchnikoff's views of inflammation are accepted, then we must start afresh, and include in our definition of the process phenomena that have never been so included before. By his experiments, he attempts to show that the primal cause of inflammation is a digestive reaction of the protoplasm against a noxious agent. Examples of intravascular inflammation without diapedesis, as illustrated by recurrent fever and the formation of intravascular tubercles, have, so far as we know, never before been included in what is ordinarily understood by inflammation; but a very tenable case is made out by Metchnikoff in support of his opinion, and it is not surprising that he should define inflammation as follows: "Inflammation in its entirety should then be regarded as a phagocytic reaction of the organism against irritant agencies, a reaction which is sometimes accomplished by mobile phagocytes alone, but occasionally with the concurrence of vascular phagocytes, or with that of the nervous system." Inflammation then is not a process for the regeneration of tissue, nor a provision for the absorption of, and consequent riddance of the organism from, dead and useless material, but it is a battle against noxious agencies, especially virulent bacteria. "Even if all his views are not accepted, facts and arguments have here been laid before the scientific world that demand the most careful examination and consideration, but the feeling may well be held that the author has limited himself too much to one aspect of his subject, although this is prepared for in his preface, by his pointing out that several sides of the inflammatory process have been intentionally omitted." [1]

Steven concludes his review of Metchnikoff's work as follows: "We

[1] Steven, loc. cit.

finish our careful study of the work with the conviction that although it is a great one, and likely to be a lasting one, it is the work of a biologist pure and simple, and cannot possibly be that of a practical physician or pathologist;" which is a dismissal of the subject that is hardly in consonance with its importance. It is only by such work as this—coming from the experimental laboratory—that the views of either pathologist or clinician are ever to be enlarged or modified.

Chemiotaxis of Leucocytes and Bacterial Infection.

A very important branch of the subject that occupies us at present has received attention in the study of the chemiotactic powers of the leucocytes and their relation to bacterial infection. Massart and Bordet[1] have studied it very thoroughly.

After a number of considerations upon the progress of our knowledge of bacteria, and having spoken of the experiments upon animals in order to make them resistant to the invasion of bacteria, instancing the fact that phagocytosis and the bacterial condition of the fluids play the principal part in this result, they raise the point that a species of animal which is ordinarily refractory to a bacterium may, under the influence of various causes, become susceptible to its attacks, and that this modification constitutes the *predisposition to infectious disease.*

Among the causes that weaken natural or acquired immunity are (1) the introduction of products secreted by the species of bacterium inoculated, (2) the introduction of products secreted by a different microorganism, (3) exposing the animal to conditions unfavorable to its existence, or the production of traumatic lesions, (4) the introduction of certain definite chemical substances, (5) the introduction of anæsthetics. The numberless facts cited permit the following conclusions: That the injection of bacterial products and of certain definite chemical substances, exposing the animal to abnormal conditions of life, as well as the employment of anæsthetics, diminishes the resistance of the economy to an invasion of bacteria. It follows, therefore, that it is necessary to discover by what means the different factors just spoken of act upon the mechanism of infection. Bouchard, to explain this influence, has suggested two theories which will be spoken of hereafter, but first it is necessary to consider the chemiotactic power of the leucocytes, for it has been very definitely shown that this kind of irritability of the white corpuscles plays a special part in diminishing immunity. For many years it has been known that certain substances contained in bacterial cultures produce purulent collections at the points where they are injected, and the different experiments upon the subject show distinctly that certain bacterial products have the power of attracting the leucocytes, which are thus brought in contact with the bacteria that attempt to invade the economy, and may destroy them at once, before they have time to secrete great quantities of poison.

Metchnikoff's studies make it more and more probable that immunity rests in great part upon phagocytosis, and in order that this shall take place effectively, the white globules, which are among the most active phagocytes, must collect at the threatened parts of the economy; and

[1] Annales de l'Institut Pasteur, Juillet, 1891.

Bouchard's[1] results, as well as those of Massart and Bordet, show distinctly that in animals in which the immunity has been enfeebled by one of the predisposing causes, the *leucocytes lose the faculty of collecting in front of the bacteria.* In regard to what produces this loss of chemiotactic power in the leucocytes, Bouchard concludes that the bacterial products exercise a stupefying action upon them. When a sterilized culture of bacteria is introduced into the circulation, the white globules appear paralyzed and no longer collect in the neighborhood of the virulent bacteria; but the observations of Massart and Bordet, and of Metchnikoff,[2] show that this loss of power does not result from paralysis of the leucocytes, because they move in their ordinary way, and also englobe small foreign bodies as well as bacteria other than the invading ones; and Bouchard, in his later essay upon the Theory of Infection, insists upon a second hypothesis, maintaining that pathogenic bacteria, or at least those he has worked upon, secrete a substance that paralyzes the vaso-dilator centre, and that the vaso-dilator paralysis thus produced prevents the inflammatory phenomena, especially vascular dilatation, exudation, and diapedesis, from occurring in the injured part. In this way the bacteria are relieved of one of the destroying causes, phagocytosis, and can develop, flourish, and produce their secretions in perfect freedom; but Massart and Bordet object to the methods employed to prove this, that it has not been demonstrated that the desiccation of the nerve, or its having undergone several times and at intervals the action of induced currents, does not play a principal part in the results mentioned by Charran and Gamaleia,[3] and by Charran and Agley.[4] To accept the conclusions of these authors, it must be admitted that successive and supposed identical irritations have given reflexes of depression equal among themselves, which is a point not yet determined.

The method adopted by Massart and Bordet was employed upon white rabbits and guinea-pigs. They inoculated into the animals, subcutaneously, a very small quantity of the bacilli of blue pus, and at the same time made an intra-peritoneal or subcutaneous injection of a sterilized culture of the same bacillus, or of the bacillus prodigiosus. Immediately after this operation, the middle of one of the ears was very lightly cauterized, and it was easy to determine whether this procedure produced vascular dilatation, which their experiments showed that it did. Even if the doses were made so large as to produce death by direct toxic effect, they were not capable of interfering with vascular dilatation. These observers have attempted to discover for themselves what are the predisposing causes of infection, studying the method of action of four—the injection of bacterial products, varnishing, anæsthesia, and the presence of lactic acid—and have reached the conclusion that the increase of receptivity is dependent upon various causes, of which the following are some: First, the leucocytes float in fluids charged with products secreted either by bacteria or by altered cells.

[1] Action of Products Secreted by the Pathogenic Bacteria. Paris, 1889; and also, Upon a Theory of Infection. Proceedings of the 10th International Medical Congress. Berlin, 1890.

[2] On the Struggle of the Cells of the Organism against the Invasion of Bacteria. Annales de l'Institut Pasteur, 25 Juillet, 1887.

[3] On Inflammation. Comptes Rendus de la Société de Biologie, 5 Juillet, 1890.

[4] Experimental Research upon an Action of Products secreted by the Bacillus Pyocyaneus on the Vaso-motor Nerve System. Arch. de Physiol. Norm. et Pathol., Octobre, 1890.

These products attract the phagocytes, retaining them in the tissues, and prevent their migration toward the menaced points, while, in a normal condition, the phagocytes travel toward these points by reason of their chemiotactic power; second, the leucocytes are repulsed from the regions invaded by the pathogenic bacteria, by reason of the presence of products that exercise upon them a negative chemiotactic power; and third, anæsthetics facilitate or aggravate infection by suppressing the irritability of the phagocytes.

Muscular Phagocytosis and Parenchymatous Inflammation.

Another and very important contribution to the subject of inflammation in general is made by Metchnikoff and Soudakewitch [1] in the result of their work upon Muscular Phagocytosis, which is a partial study of Parenchymatous Inflammation. In this discussion they raise the question at the very first: Are the leucocytes the sole agents capable of producing phagocytosis?

Even if their *rôle* does preponderate when the destruction of bacteria introduced into the organism is concerned, it does not follow that they alone in every case have the power of producing the disappearance of certain elements that are foreign, or have become useless to the economy. Metchnikoff has studied the mechanism by which the tails of tadpoles are thrown off when they become adults. Looss and Bataillon had already gone over the problem, and had concluded that the muscular fibres were dissolved in the ambient fluid, and that the leucocytes had nothing to do with it. These results would of course weaken very seriously the phagocytic theory, provided that they were exact; but according to Metchnikoff they are very far from being entirely so. He recognizes, it is true, that the white corpuscles take no part in the disappearance of the contractile substance, but this latter does not dissolve purely and simply in the intercellular fluid, and other elements than the leucocytes are concerned in englobing and digesting it. In a muscular fibre there is a peripheral part that is non-striated, made up of amorphous and very finely granular protoplasm. It is usually found in the shape of a band or layer placed immediately within the myolemma about the nuclei. This protoplasm, to which is given the special name of *sarcoplasm*, is possessed of very great vitality, and is also possessed of very marked amœboid movements, and it is to this substance that is ascribed the part of absorbing the striated material near which it is placed, and of producing its dissolution. Some time before the metamorphosis of the animal (the tadpole), the nuclei multiply and produce, within the sarcoplasm, special cells. The muscular phagocytes which send amœboid prolongations between the different bundles separate them and break up the fibrillæ; by their action, these are also broken into fragments which are more and more separated and end by being absorbed. Therefore, although the results of Looss and Bataillon are exact as far as the non-intervention of the white globules is concerned, they are not exact as to denying the existence of phagocytic phenomena. These last are, on the contrary, very active, but their

[1] Ann. de l'Inst. Past., Janv., 1892.

study shows us that *phagocytes* and *leucocytes* are two things which must not be confounded.

Some work of Soudakewitch on the modification of muscular fibres in trichinosis confirms that of Metchnikoff. When a trichina is installed in a muscle, it is the same elements, the same "muscular phagocytes," that are formed, and that tend to produce the resorption of the fibrillæ that have already been destroyed by the parasite. The latter by its movements ends by destroying all the living cells, and there is therefore left only a mass of degenerated elements. At this moment alone, new leucocytes are introduced into the bundle to break it up, and englobe the *débris*. These two pieces of work are of great value, as showing how far phagocytosis is of importance in varying cases, and as showing also that it can be carried on not only by leucocytes, but also by elements of a different nature and conformation.

Electricity in Phagocytosis.

As a part of the study of phagocytosis, and, from one point of view, of inflammation, the action of various agencies upon the phagocytes is of importance, and among these agencies none are so subtle and instructive as electricity. The subject has been worked out by a number of experimenters, notably Kühne,[1] Engelmann,[2] and especially Verworn.[3]

A summary of the conclusions of the latter is as follows: In one chapter, he studies the excitation of rhizopods by the galvanic current, and he uses for this purpose electrodes that he considers unpolarizable, employing a battery of twelve elements, in bichromate, as the generator of his electricity. As the result of the first series of experiments, he concludes, first, that the law of contractions hitherto considered applicable to all contractile organisms is not so applicable, and that there exists a series of elements that are not governed by it; and, second, that there is not a common law of contraction for the three species upon which he experimented. The second part of his work consists of experiments upon the ciliated infusoria, to show the influence exerted by electricity upon their orientation and their displacement. He experimented upon the Paramœcium aurelia, the Halteria grandinella, the Stentor cœrulea, the Stentor polymorphus, the Colpoda cucullus, the Coleps hirtus, etc. He found that all these animals, when watched in a drop of water through which an electric current was passed, moved toward the negative pole, with undulations more feeble as the current was less. If the current was broken, they all took their freedom again, and became disseminated throughout the drop of water. As soon as the circuit was closed, they arranged themselves in such a way as to present their anterior extremities toward the negative pole, and directed themselves toward it. They followed therefore the direction of the electric current, passing from the positive to the negative pole. This phenomenon might be attributed to a cataphoric action, and, in fact, it is known that inert particles which are very small, and are held in suspension by a fluid traversed by a current, are mechanically trans-

[1] Researches upon Protoplasm and Contractility, Leipsic, 1864.
[2] Pflüger's Archiv, Bd. ii., 1869. [3] Ibid., Bd. xlv., 1889.

ported by it in the direction in which it is travelling, and therefore come, as do the infusoria spoken of above, from the positive to the negative pole; but Verworn thinks that in this case the corpuscles travel in a straight line, that they do not arrange themselves so that their antero-posterior axis is in the direction of the current, and that their progress is slow. On the other hand, if the infusoria be anæsthetized by chloroform or ether, the same current that before produced a manifest galvanotropic effect no longer does so, and it is therefore evident that the rapid movement of orientation observed is a *manifestation of sensibility.*

Dineur [1] repeated the latter experiment upon a number of infusoria, and observed the existence of the galvanotropic effect, notably in the paramœcium, and especially in the rassula, but found that he was obliged to use a current with sufficient electromotive force to produce a rapid and very apparent electrolysis. If the current was not sufficiently energetic to develop bubbles of gas, the galvanotropism was not manifest, and he therefore considers that Verworn must have employed currents sufficiently strong to decompose the fluids containing the infusoria, and able therefore to influence them chemically. In such a problem, it is difficult to separate the part played by true galvanotropism from that produced by chemiotaxis. It is known that the inferior organisms react to changes in the chemical constituents of the fluid in which they move, and this kind of sensibility, studied by Pfeffer [2] and Massart,[3] has received the name of positive or negative chemiotaxis, according as the infusoria observed are attracted or repelled. The only point that it is desired to make here is that in order to be considered due exclusively to galvanotropism, the orientation and displacement of the infusoria toward the negative pole observed by Verworn must be also produced by non-electrolytic currents. New experiments, with a more feeble electromotive force, must be made to illustrate this point.[4] The fact that leucocytes, considered as free cells or as independent organisms, possess an irritability analogous to that of monocellular beings, has been completely demonstrated, especially so far as concerns their tactile sensibility, or chemiotactic power.

The tactile sensibility of the leucocytes described by Ranvier [5] has been recently experimented upon by Massart and Bordet,[6] their method of procedure being as follows: A drop of lymph is placed on a large covering-glass, and this is inverted and placed over a cell in a piece of heavy plate glass covered with water, so that the fluid is entirely prevented from evaporating. At the end of a little time, the leucocytes are mostly collected on the lower surface of the cover-glass, and on the free surface of the suspended drop, some only remaining in the middle of the drop. According to the situation that they occupy the leucocytes have different forms; the cells that are in contact with the glass have peculiar shapes, presenting certain fine prolongations by means of which they fasten themselves to the lower surface of the glass, as if with tentacles. They have been seen spread out in such a way on the lower surface of the glass as to disappear almost completely, so that they could no longer be detected except by the eyes of the experimenter which had followed

[1] Ann. de la Soc. Roy. des Sciences Méd. de Bruxelles, t. i. No. 1, 1892.
[2] Arb. a. d. bot. Inst. z. Tubingen, Bd. i. S. 363; Unters. a. d. bot. Inst. z. Tubingen, Bd. ii., 1888.
[3] Archives de Biologie, 1889. [4] Dineur, loc. cit. [5] Treatise upon Histology.
[6] Journal de la Société Royale de Médecine de Bruxelles, 1890.

them during their transformation, and then only by means of the special refrangibility of the edge of the protoplasmic layer thus formed on the lower surface of the cover-glass. The *floating* cells are still round, but all (at the surface of the drop) have one or two needle-shaped prolongations. They thus show that every resisting surface coming in contact with the leucocyte produces a reaction on its part, manifested by throwing out and extension of the pseudopodia; the globule reacts by placing itself in contact with the excitant by the largest possible surface. This tactile sensibility explains the penetration of leucocytes into porous bodies, such as elder pith, and it is also this peculiarity that accounts for the diversity of the shapes of the leucocytes contained in a drop of lymph examined under the microscope. Suspended under a cover-glass, these shapes vary, in fact, according as the cell is in contact with the glass or with the surface of the drop, where superficial tension acts as the resisting surface, or on the borders of the drop where the two causes act at the same time.

The same authors, Verworn and Dineur, have also studied the chemiotactic powers of the leucocytes, and have established a fact of the greatest interest in pathology, that the chemical sensibility of the leucocytes is excited by the products of bacteria (the staphylococcus pyogenes albus, bacillus choleræ gallinarum, bacillus typhi, bacillus anthracis), the ptomaine of the first showing the most active attraction. The products of disintegration of the injured cells possessed the same property, as well as certain products of oxidation of the albuminoids, like leucin.

These experiments upon chemiotaxis were undertaken by Gabritchewsky,[1] who applied the method of Massart and Bordet to a long series of substances, which he divided into, first, substances possessed of negative chemiotaxis that repelled the white corpuscles (concentrated solutions of the salts of sodium and of potassium, lactic acid from one-tenth per cent. to ten per cent., etc.); second, substances of indifferent chemiotactic power (distilled water, medium and weak solutions of the salts of sodium, one-tenth per cent. to one per cent., antipyrin one per cent., peptone one per cent.); and third, substances of positive chemiotactic power (papayotin in one-per-cent. solution, and different ptomaines). The method employed was that of Pfeffer, of placing in the peritoneal cavity, or under the skin in the cellular tissue of the animal, capillary tubes of glass, closed at one end and previously filled with the solution to be used for study. As a result, the conclusion may be drawn, that in a cold-blooded animal leucocytes are sensitive to the chemical composition of the medium in which they live, and that the modifications of this medium are of a nature to influence the direction of their movements.

Dineur[2] has proposed to find out whether the leucocytes are equally endowed with chemiotactic powers, choosing for his source of electricity a single Daniell cell. He employs capillary tubes of glass, placed much as in the experiments of Massart and Bordet, upon an ebonite plate, measuring one centimetre by four. He fixes, by means of a drop of sealing wax, three glass capillary tubes of the same apparent diameter, placed so that their extremities extend about two centimetres beyond the edge of the ebonite plate. These ends should be broken square across, and so placed as to converge toward each other. They are

[1] Ann. de l'Inst. Past., 1890. [2] Loc. cit.

filled with the physiological solution of chloride of sodium (six-tenths per cent.) exactly neutral in reaction; being filled, there is passed into each tube a very fine platinum wire to the end of the tube, extending over the edge of the ebonite plate, care being taken that no bubble of air shall enter at the same time; the entire absence of any bubble of gas must be ascertained by means of a lens, and if any is present it must be removed with the greatest possible care; then the ends of the tubes through which the wire has been introduced (and out of which it extends a little way) are closed by a drop of sealing-wax, which must be done with the other ends placed in a watch-glass of the chloride of sodium. The animal to be experimented upon is thoroughly fixed upon the board, and an incision exactly long enough for the introduction of the tubes is made in the abdominal wall. The incision must be made with the greatest possible care—with a bistoury heated to a cherry red—and absolutely all hemorrhage must be avoided. Finally, the tubes are placed in the cavity in such a way as neither to bruise nor to wound the intestinal folds, and great care must be taken not to raise the edges of the wound, in order that no air may enter the peritoneum; for if this were done, it might happen that the extremities of the wires, instead of being bathed in the serum which should join them and complete the circuit, would terminate in a gaseous bubble which would break the current and make the experiment negative. In order to avoid this, some cubic centimetres of the physiological solution of chloride of sodium may be injected into the cavity, but if the peritoneal serum is sufficient to moisten the tubes well, this procedure is unnecessary.

Everything being thus prepared, the current is passed through two of these electrodes, the third acting as a control. If the intensity of the current is to be diminished, a resistance is introduced at some point of the circuit, although the distance of the two extremities of the wires produces so considerable a resistance that a galvanometer must be used at the beginning of the experiment, in order to be sure that the current is passing through. This also is the reason why the extremities of the tubes must be placed as close together as possible. The animal is covered over, and the whole apparatus placed in a moist chamber. At the end of some time, often exceeding twenty-four hours, the microscopic examination is to be proceeded with, and here again the galvanometer must be employed, in order to be certain that the current is still passing. Then the capillary tubes are removed with very great care, in order to avoid disturbing the little fibrinous collections that may be gathered over the end of one or the other of the tubes, which could easily be destroyed if the removal was effected carelessly. The whole is then placed on a slide, the free ends of the tubes are covered with a cover-glass, and a few drops of the solution of chloride of sodium are introduced under it. In this way the capillary tubes can be very easily observed under the microscope, and the evaporation of their contents is not to be feared. If, in spite of all precautions, a bubble of gas has entered the tubes, or if they are in any way obstructed, the result, of course, is not valuable, any more than when, as often happens, an end of one of the tubes has broken some of the small vessels; and it is easy to see that it is only after having repeated the same experiment many times that one can secure a sufficient number of observations, free from any source of error. In Dineur's experiments he has obtained the

same result in every case in which he could exclude sources of error, and as a result of a long series he has discovered certain interesting properties of the white corpuscles, which he summarizes as follows: "First, the leucocyte is endowed with a special sensibility to electricity. I propose to give to this property the name of *galvanotaxism*. Second, the galvanotaxism of the normal leucocyte guides it with a marked preference toward the positive pole (positive galvanotaxism). Third, the galvanotaxism of the leucocyte in inflammation directs it, on the contrary, toward the negative pole (negative galvanotaxism)."

These experiments are of the greatest value and interest, as tending to show the relationship of the action of the leucocytes and phagocytes (for we have seen they are not necessarily the same thing) toward excitation of various kinds, and also as tending to uphold that theory of inflammation which forms the keynote of this paper.

SUPPURATION.

Suppuration being but a part of the same process of inflammation, but carried further, may next claim some attention; and in the same way as inflammation, must this process be considered from a new point of view, as is well illustrated by Shattock[1] in his remarks before the London Pathological Society, in which he claims that the time has arrived for a revolution in the terms at present in use, as applied to suppuration.

The terms suppuration and pus are purely anatomical, and include things quite different in their etiology. Setting aside larger questions, the process of acute suppuration can be etiologically distinguished from other forms, and is as specific in its nature as tuberculosis or syphilis, as is now well established by experiment. Koch's four postulates can all be fulfilled in this case, and the doctrine can be confirmed by the control experiment of introducing aseptic chemical irritants beneath the skin of animals, which, if the animals are healthy, produces inflammation, but not suppuration. A strict parallel can be drawn between tuberculosis in its different manifestations and acute suppuration, which is given in tabular form thus:

Tuberculosis.

Local.	Glandular.	General.

Pyosis.

Local.	Secondary Glandular Abscess.	General.
Acute Circumscribed Abscess.		
Diffuse Suppuration.		

In order to bring out these facts, Shattock suggested the term, "Pyosis." Generalized Pyosis will then be what is named Pyæmia; Glandular Pyosis will denote the secondary glandular infections; and the acute abscess or acute suppuration of a bowel will be Pyosis in a local form.

Shattock also speaks of certain observations on the presence of peptone in the pus of acute abscess. This can best be demonstrated by shaking

[1] Brit. Med. Journ., Feb. 6, 1892.

the pus with half its bulk, or less, of a saturated solution of ammonium sulphate, then adding crystals of the same salt to saturation, and filtering. If a drop of copper sulphate solution is then added to the clear filtrate, no precipitation is produced, for the ammonium has precipitated all the proteids except peptone, and on adding an excess of solution of caustic potassa, a dense white precipitate of potassium sulphate is thrown down. On this subsiding, the pink coloration of the clear supernatant fluid can be seen. Shattock has been able, by dialyzing pus, to show the same with the biuret reaction. For the separation of the albumoses, Dr. Sidney Martin's method was necessary. The presence of albumose and peptone in pus is not peculiar to the action of pyogenic bacteria. Dr. Martin had shown both in the alkaline albumin in which he had grown the bacillus of anthrax. The peptone in all the specimens tried was very small, being indeed a mere trace, and the amount of albumose was much larger.

The summary of this work of Shattock's leads naturally to a mention of other experiments of the same nature (upon soluble products of bacteria), but of a very different and more important class.

Action of Soluble Bacterial Products upon Inflammation.

Charran and Gamaleia[1] thus summarize the results of their investigations upon the action of soluble bacterial products upon inflammation:— Buchner and Bouchard have established that the intensity of a local bacterial lesion is most often proportionate to the resistance of the inoculated animal. It has also been demonstrated that this local lesion is always rich in leucocytes, except in cases of absolute vaccination, a direct result of this resistance of the animal. In order to explain the presence or absence of these leucocytes according to the condition of immunity, or of receptivity, certain authors have considered that in the first case the white corpuscles are attracted by the bacterial secretions, or at least become accustomed to their action, which in the second case produces an effect of repulsion, or of paralysis.

Bouchard has placed beyond doubt, by his experiments, the property possessed by the soluble products of *preventing the appearance of the leucocytes*. He has, in fact, shown that the diapedesis can be arrested if certain sterilized cultures be injected, and the authors quoted above bring forward new facts to support this observation. If one rubs croton oil, according to Samuel's method, upon the ears of rabbits, there appear at the end of four hours redness and swelling, and in about eight hours an exudation which is very abundant, and which is sometimes accompanied by the formation of blisters; but if after having subjected an animal to the same treatment with croton oil, there are injected into the veins (four or six times every two hours) 5 to 8 cubic centimetres per kilogram of the sterilized culture of the bacillus pyocyaneus, none of the foregoing phenomena occur. The alterations only appear on the following day, if through fear of poisoning the injections are stopped. As a result, therefore, it appears that the secretions of certain pathogenic agents can act upon inflammation as a whole, preventing congestion and transudation of plasma, as well as diapedesis.

[1] Comptes Rendus, t. 110, p. 1154.

The question as to whether these soluble products act directly upon the vessels or through the medium of the nerves is not yet settled, and further work is to be carried out by these authors to discover if possible what other substances, and in what degree, can produce the same effects.

Destruction of Bacteria by Amœboid Cells in Inflammation.

Again, and in a very important measure supplementing the work of Metchnikoff, comes that of Armand Ruffer[1] on the destruction of bacteria by the amœboid cells in inflammation.

In a memoir published in the British Medical Journal for May 24, 1890, upon the same subject, Ruffer was led to the following conclusions: First, the inflammatory phenomena following the introduction of the bacilli of symptomatic anthrax under the skin of the guinea-pig have a protective and useful character; second, the destruction of bacteria at the point of inoculation is produced entirely by the amœboid cells contained in the inflammatory exudation.

He based these conclusions upon the effects seen in guinea-pigs, but he has also studied the action of the same virus (of symptomatic anthrax) upon rabbits—animals that were considered refractory to this disease by Arloing, Cornevin and Thomas, Roux and Nocard, and many others. He has carried on his experiments with the bacillus Chauvoei (symptomatic anthrax), endeavoring to find the effect exerted upon it by the living fluids and cells of rabbits. He used for the purpose the first and second vaccines of Arloing (prepared by the desiccation of the muscles of animals dead of symptomatic anthrax), and a dose of the virus was always very carefully weighed before being placed under the skin of the rabbit. His first experience led him to believe that this organism did not grow in the rabbit, for having injected a very small quantity, five milligrammes, of the second vaccine under the skin of a rabbit, and having examined the point of inoculation twenty-four hours afterward, he was unable to find any bacilli; but upon very carefully staining sections made from the inflammatory tissue, he always found a few leucocytes surrounding the remains of the vaccinal powder, and a few of the typical bacilli englobed in these cells; if a larger quantity of the vaccine (five centigrammes) were used, the bacilli were extremely numerous at the point of inoculation. Larger doses produced in the animal typical symptomatic anthrax, and inevitably killed it after from forty-eight hours to three days, and under these circumstances a very large number of the bacilli could be found at the point of inoculation, englobed in the leucocytes and in process of degeneration.

The degenerative changes in the bacteria were absolutely the same as those seen in the leucocytes of guinea-pigs, and these facts led Ruffer to try if the living fluids of animals comparatively refractory to the bacillus Chauvoei possessed a bactericidal power over this organism; a question which had already been studied partially by Roger, who made the remarkable observation that the serum of guinea-pigs, which are not refractory to symptomatic anthrax, had a very great bacteri-

[1] Ann. de l'Inst. Past., t. v. p. 673.

cidal power over the bacillus Chauvoei, while that of rabbits, which are relatively refractory, was harmless toward this same bacillus, another confirmation of the fact that one cannot judge of the immunity of an animal to a disease by the bactericidal power of its dead fluids toward the bacterium of this disease. Moreover, it has already been emphasized by Ruffer himself,[1] that in the same way that the living blood differs by its optical, chemical, and physiological characteristics from the dead blood, in the same way does the action of living fluids upon bacteria differ entirely from that of dead fluids.

Depending upon the principle that in order to study the action of the fluids of the economy upon a bacterium, they must be observed in the living body, a method employed by Metchnikoff and others was used. The powder to be studied was enclosed in a little bag of filter-paper, like what the pharmacists use to put up powders, the two folds of the bag being closed with paraffin. The bag, containing five decigrammes of the first vaccine, was introduced for twenty-four or forty-eight hours under the skin of a large rabbit, then taken out, the contents examined, and the whole placed in absolute alcohol to harden it well. The appearance varied a little if a cover-glass preparation was made from the powder. In the centre of the little packet, most of the bacilli developed were normal, although the growth of some of them was less than that of their neighbors. The contour of the latter was irregular, and staining by Gram's method was less intense, and frequently replaced by the contrast color of vesuvine. Very frequently long filaments could be observed in which some bacilli appeared perfectly normal, and stained well with gentian violet, while others had an irregular contour, and stained by vesuvine. It would be extremely difficult to decide whether these differences were due to the partial degeneration of the bacteria, or whether one had to do simply with organisms whose development had been for one reason or another retarded. If the powder was examined forty-eight hours after inoculation, these irregular forms instead of being more numerous were much less so, and even might not be found at all; and if, instead of examining the central portion of the powder, the dust made by it on the surface of the paper was studied, there were to be found there a quantity of absolutely normal bacilli. Here and there in the interior of the sac there were to be found a few leucocytes, and these experiments seemed to show conclusively that the bacillus Chauvoei grew perfectly in the tissues of refractory rabbits. Sections made of the paper of the bag (hardened in alcohol, then in chloroform, the chloroform saturated with paraffin, and finally in pure paraffin) showed many interesting things: first, a very great activity of the bacilli, for it could be seen that they had forced a passage for a certain distance between the fibres of the paper, while on the other hand the leucocytes, attracted by the poison secreted by the bacteria, had penetrated in immense quantities between the fibres of the paper, so that an encounter between the bacteria and the leucocytes had inevitably taken place at a certain point. It could be seen that certain of the leucocytes in advance contained bacteria, either normal or in process of degeneration, while others had themselves perished in the struggle, as could be clearly seen by the signs of degeneration that they presented. Behind this advance guard could be found a mass of

[1] British Medical Journal, May 24, 1890.

leucocytes, containing an enormous number of the bacilli more or less degenerated, and it was curious to see the small polynuclear leucocytes assembled in enormous numbers just at the points where their presence was useful. Finally, near the external surface of the section not a single bacillus could any longer be found.

It was exceedingly important to know whether the second vaccine was still more enfeebled under the influence of the living fluids of the rabbit, and the following experiments were undertaken for this purpose. Fifteen centigrammes of the second vaccine were divided into three equal parts, and five were inoculated into a rabbit. An absolutely typical tumor developed in this animal, which disappeared gradually, and the animal completely recovered. A second portion (five centigrammes) of the vaccine was enclosed in filter-paper and placed under the skin of another rabbit. Twenty-four hours after, the wound was opened, and the paper cut in a way to permit the contents to escape in the tissues; the animal died forty-eight hours afterward of a typical symptomatic anthrax. The third portion of five centigrammes was introduced under the skin of a third rabbit in the same way. Forty-four hours afterward the paper was broken by pressure outside of the skin, and this animal died in twenty-four hours of symptomatic anthrax. Other experiments were undertaken to show that this result was not due to the fact that the virus had been introduced into a region enfeebled by the presence of the filter-paper. As the result of all, it was shown that in guinea-pigs, as in rabbits, the bacilli of symptomatic anthrax develop as soon as they are introduced into the organism, and that the leucocytes collect in the region where the virus is found; that the leucocytes are attracted by the chemical poison secreted by these bacteria, and that, once emigrated, they actively attack the organisms, englobe, and destroy them.

It is to be remarked that the cellular emigration to the point of inoculation varies inversely with the quantity and the strength of the virus introduced, but is proportional to the duration and benignity of the disease. The emigration of the leucocytes is feeble or negative when a large quantity of extremely virulent bacilli are injected, but becomes more marked when the inoculated bacilli are less numerous, or when they have been previously attenuated; further, if the leucocytes are prevented by any cause, mechanical or chemical, from reaching the virus, the disease makes progress, and the animal succumbs. The living fluids of an animal naturally refractory, or of an animal whose immunity has been reinforced by an anterior inoculation, have no bactericidal action upon the virus of symptomatic anthrax, since this virus, bathed in its fluids, if taken out and again injected into a refractory animal, produces its death; finally, the fluids of a diseased animal appear to have no attenuating or bactericidal action upon the bacterium of the same disease.

What has been said upon cellular emigration cannot in any way be applied to exudation, another phenomenon accompanying inflammation. The two processes appear to be almost in inverse relation, as can be seen by comparing, for example, the sanguineous exudation of a rabbit, dying in twelve hours after inoculation with the bacillus Chauvoei, and the thick, compact, almost solid substance that accumulates about the virus inoculated in a refractory animal. It appears to be

evident that, in this disease at least, the serous exudation is always more abundant when the disease is most virulent, but in spite of the enormous quantity of this exudation, the bacteria appear to be in no way hurtfully affected by it, but, on the contrary, they flourish in it, and acquire an extraordinary virulence. Another very evident point brought out is that if the substances produced by the bacteria have already penetrated into the blood, the poison secreted by the same organism inoculated into other parts of the body of the animal does not attract the leucocytes, as is shown by the results obtained with the bacillus pyocyaneus. If a drop of a culture be injected into the eye of a rabbit, the leucocytes emigrate in great quantities to the point of injection, but if the poison produced by the bacillus pyocyaneus is previously circulating in the blood, the leucocytes do not emigrate, and the eye remains intact. Finally, it seems necessary, before accepting the theory advanced by Massart and Bordet,[1] to study the action upon inflammation of certain well-defined chemical substances injected at the same time under the skin and in the veins, which is a work that Ruffer promises to carry out very soon.

Bacteria Causing Inflammation.

Looking upon inflammation from the point of view here adopted—that it is a symptom of the effect of some irritant agent, and the advance of the phagocytes against this agent—and considering, as we are obliged to do, that the most commonly occurring of these irritant agents are to be found among certain forms of the bacteria, it is impossible to have a proper idea of the subject without a certain knowledge of what these bacteria are. Of course, a consideration of the whole subject of bacteriology would be out of place here, but the activity of these micro-organisms has been shown to be so great and so widespread that a mention of a few of them is necessary. The number of those that have been shown to produce an inflammatory reaction, which inflammatory reaction not infrequently goes on to suppuration, is very large indeed, so that it is not possible to speak in detail of more than the most common; and the mention of those spoken of must also be limited to the organisms occurring in man, for the number of bacteria which have been found to produce inflammatory changes in the lower animals is much greater than the number of those which have been found, either by inference or actual experiment, to produce the same changes in the human being; so that if the effort were made to consider all that may produce inflammation either in man or in the lower animals, an altogether too great prominence and space would of necessity be given to their description.

Of those that produce inflammatory and suppurative changes in the human tissues, the most common is (1) the *Staphylococcus Pyogenes Aureus*. This is an organism occurring very often in pus, in the air, and in earth, in the form of irregularly arranged micrococci of variable size, the medium diameter being 0.87μ. It is non-motile. On gelatin plates, at the end of forty-eight hours, it appears as small points with a yellowish tinge and sharp edges at the non-liquefied gelatin.

[1] Vide supra.

In needle cultures it grows as a granular grayish line, which after about three days turns yellowish, afterward of an orange color, liquefies the gelatin, and sinks to the bottom of the liquefied portion. On agar-agar, after twenty-four hours, there is a dark opaque colony, which subsequently turns from yellow to orange. On potato, it grows as a thin whitish layer, which afterward becomes slimy and orange-yellow, producing a strong putrefying odor. On blood serum, it grows as on agar-agar. It develops best at from 30° to 37° C., somewhat more slowly at summer temperature. It develops rapidly; spores have not been observed, but it shows a marked resistance to destructive agencies of various kinds, is facultatively aerobic, liquefies gelatin, stains well after Gram's method, and has pathogenic effects upon various lower animals.

(2) Another very common organism of the same class is the *Staphylococcus Pyogenes Albus*, which develops precisely as does the preceding, excepting that it produces no pigment in its colonies.

(3) A third is the *Streptococcus Pyogenes*, found in progressive erysipelatous processes, and occurring as small cocci arranged in chains often made up of as many as thirty elements. On gelatin plate cultures, it grows as fine round granular points. In streak culture, it is thickest in the middle, its color a dark brown, the contour growing thicker, swelling, and terrace-shaped. In needle culture in gelatin, the colony grows along the course of the needle track as a finely granular line. On agar-agar, in a needle culture at from 35° to 37° C., it grows as a band-like grayish-white line with points. There is no surface growth, and only a very slight growth upon potato, the cocci changing so that under the microscope they appear of different sizes. On blood serum it develops as a thin band-like layer. Its best development is at 35° to 37° C., summer temperature being less favorable. Its growth is slow, it is facultatively anaerobic, non-liquefying, stains by Gram's method, and produces a slow erysipelatous suppuration in the lower animals.

(4) Very similar is the *Streptococcus Erysipelatis*, the only marked difference between the two being the greater apparent activity of the latter in the living animal tissues.

(5) The *Gonococcus* occurs in secretions from mucous membranes affected with gonorrhœa, as kidney-shaped diplococci with the concavities facing each other. It seems to have a rotary and oscillating movement, but no true motility. There is no growth on gelatin, agar-agar, or potato, but it develops well on acid gelatin. On human blood serum, it develops as a very thin, almost transparent layer, which by reflected light appears grayish-yellow, with a moist glistening surface, whose edges appear diffused in the surrounding medium. The best temperature for its development is from 33° to 37° C. Its growth is very slow. It stains best with fuchsin or methyl violet, but does not stain by Gram's method. Successful inoculations have been obtained by Bumm.

(6) The *Diplococcus Intracellularis Meningitidis* has been obtained in six cases in the fresh exudation of cerebro-spinal meningitis, occurring as micrococci, usually in pairs or in small masses, and in the interior of the pus cells in the exudation. There is no growth upon gelatin, but upon agar-agar there is a free viscid growth, gray by reflected light, grayish-white by transmitted, the growth occurring only near the

surface of the needle track. On plates of one-per-cent. agar-agar and two-per-cent. gelatin, it develops as very small colonies in the interior of the mass, with larger ones upon the surface, of a grayish color. In the former, the small colonies under the microscope appear round or slightly irregular, finely granular, and of a yellowish-brown color. The superficial colonies have a yellowish-brown nucleus, surrounded by a more transparent zone. There is no growth upon potato, and a very slight colorless growth upon blood serum. There is no development at the room temperature; it only grows at the temperature of the body. It quickly loses its power of development in artificial cultures at the end of six days, and it is best to transfer it once in two days. It stains best with Löffler's alkaline methylene-blue, but does not stain by Gram's method; it is pathogenic for mice, guinea-pigs, rabbits, and dogs.

(7) An organism, the power of which in the human tissues has not yet been definitely settled, but which is found in the human secretions, is the *Micrococcus Tetragonus;* it is commonly found in the lung cavities affected with pulmonary tuberculosis, and is reasonably supposed to produce the puriform discharge from such cavities. It occurs in pairs, or fours, and is non-motile. On gelatin plates it grows as small white colonies, which under a low power appear finely granular, with a glossy look. In needle punctures, its development is not along the whole of the needle track, but occurs in isolated colonies that are sharply defined, milky white, or yellowish in appearance. On agar-agar it grows in rounded separate white colonies; on potato, as a thick slimy layer, which can be lifted up in long shreds; and on blood serum as a white, moist, irregular layer. It grows best at room temperature, slowly, is not known to produce spores, is facultatively anaerobic, does not produce gas, and is non-liquefying. It may be stained by any of the usual aniline dyes, as well as by Gram's double stain.

There are a large number of other bacteria which have been found in man, and which have been shown to possess pathogenic powers in the lower animals in the way of producing inflammatory changes and suppuration, but their number is so great that those spoken of must serve as examples, and the reader is referred for a full list and description to the Bakteriologische Diagnostik, of Eisenberg (1891), or to the Manual of Bacteriology, by Sternberg (1892).

That the bacteria named are not all of those concerned in the production of inflammatory or suppurative changes, is well shown by the experiments of Condamin,[1] in which he speaks of a case of multiple suppuration consecutive to a suppurative otitis, which presented characters different from those usually observed. The otitis developed suddenly during the course of influenza, and rapidly culminated in perforation of the tympanum, having been preceded by severe sore throat. Two days later the patient's temperature was high, and he had several rigors. An abscess developed on the back of his right hand, which was opened two days afterward. From this time a series of abscesses occurred in different parts of the body, all subcutaneous and running a rapid course. From fifteen to eighteen of these, at least, were observed, and in each case cultivations from them developed *Fränkel's Pneumobacillus* in a state of purity. The common character of all

[1] Lyon Médical, 7 Fév., 1892.

these abscesses was their quiet development; in fact, they behaved like "cold" abscesses. The pus was very thick, yellow, and odorless; there was little tendency toward diffusion, each collection tending rather to become encysted. The rapidity with which each disappeared after being opened by the thermo-cautery was remarkable.

Of course such an instance is but one of hundreds that could be quoted, but it well illustrates the difficulties of the problem of definite etiology. Again, the fact that the exact separation of the different varieties of bacteria concerned in inflammation is not yet made, is shown by all the work done to differentiate or identify two organisms, the Streptococcus Erysipelatis, and the Streptococcus Pyogenes. The latest experiments in this direction are those in the Centralblatt für Bakteriologie u. s. w. (No. 24, 1892), where it is said that the question of the identity of the micrococci occurring in chains in suppuration, and those of erysipelas, has been settled in different ways, according as the observer is governed by their resemblance in size and behavior toward staining reagents and culture media, or by the difference in their pathogenic effects. Baumgarten relies upon the first hypothesis—their identity—which rests upon an observation of E. Fränkel, who succeeded in producing an erysipelatous inflammation of the ear of a rabbit with the micrococcus in chains, cultivated from a peritoneal exudation. C. Fränkel remarks upon this, that the only further point needed to show the identity of the two bacteria depends upon the production of erysipelas in man by the pyogenic streptococcus.

Kirschner brings to support this theory an observation upon a patient who was attacked simultaneously with amygdalitis and erysipelas; an observation that had the value to his mind of an inoculation experiment. The person upon whom he made the observation was affected with phthisis, and after having received an injection of tuberculin, was on the following day attacked with tonsillitis, with a whitish exudation containing numerous streptococci, but no bacilli of diphtheria. Bacteriological examination showed these organisms to be the streptococci pyogenes. Although the tonsils did not become worse, the temperature rose to 40° C., and this persistence of the general symptoms was attended by an erysipelatous blush, which appeared on the bridge of the nose, and extended from thence over the cheeks to the ears and to the neck, receding after four or five days. Bacteriological examination of the erysipelatous vesicles showed the presence of many micrococci in chains, which were well-developed. Must it be admitted that the streptococcus of erysipelas produced the erysipelas, and the streptococcus pyogenes the tonsillitis—two different species of micro-organism producing two different affections in the same person;—or is it more probable that it was the same organism which by travelling produced the suppuration of the tonsils and of the vesicles? They were absolutely similar as far as their form and reaction went, and it is therefore probable that the streptococcus pyogenes can produce different affections according to the degree of its virulence.

From what has been said in the preceding pages, we are able to conclude that inflammation as occurring in man is, in most cases, a reactionary process against the invasion of bacteria; that these bacteria are of many varieties; that their activity in the production of the inflammatory processes is the result of the production of new toxic

principles, which act upon the body cells in the way of exciting, first, their chemiotactic, and, second, their phagocytic powers.

Necessarily, these chemiotactic and phagocytic powers do not explain all the phenomena seen in inflammation, but they surely form an important part of such explanation, and further investigation may very probably make clear some of the points which are still obscure. At all events, no statement of inflammation is complete without a summary of the knowledge thus far obtained in this direction.

WOUNDS AND WOUND-TREATMENT.

BY

FRED. KAMMERER, M.D.

SURGEON TO SAINT FRANCIS'S HOSPITAL AND TO THE GERMAN HOSPITAL, NEW YORK.

I. WOUNDS.

ALTHOUGH some modern authors still believe that an immediate union of wound-surfaces can take place without the interposition of granulation-tissue, and that the severed parts become reunited by an exact apposition of the corresponding microscopical elements of such surfaces, this view is no longer held by the majority of investigators. Even when wounds heal by primary intention, with no outward signs of inflammatory reaction, a certain amount of regenerative material is thrown out between the wound-surfaces, which, however minute in quantity, still tends to bind the latter together, and is finally transformed into a scarcely perceptible mass of cicatricial tissue.

When absolute asepsis has been secured by the efforts of the surgeon, this healing process is essentially of a regenerative nature, unaccompanied by symptoms of inflammation. Before the antiseptic era such results were infrequently obtained, and even when sutured wounds did not afterward separate, inflammatory reaction showed itself in hyperæmia and swelling along the line of suture. The causes which are instrumental in setting up such reaction in wounds are, mechanical irritation of wound-surfaces, the presence of foreign material, mainly necrosed tissues, but more especially the introduction into the wound of micro-organisms which by their multiplication give rise to the symptoms of wound-infection. We are to-day enabled to guard against the latter, but we are not always able to entirely avoid the effects of mechanical irritation and of the interposition of necrosed tissues and blood-clots between the wound-surfaces. It is well to bear this in mind, when we study the histological changes during the healing of wounds. If we could observe the latter under the microscope, we would notice, as an indication of inflammatory reaction, an infiltration of leucocytes, however small, in some parts of most aseptic wounds. But this manifestation is wholly secondary in importance. It has at times been regarded as the necessary precursor of all regeneration and repair in wounds. This theory has now given way to that which assumes that the fixed tissue and parenchyma cells are the active agents in the work of repair, and that the leucocytes which have emigrated from the blood-vessels are doomed to destruction either by absorption or expulsion, in the latter instance as the main constituents of pus.

KARYOKINESIS OR INDIRECT CELL-DIVISION.—When new tissues are formed in the body, this is always accomplished by a division and multiplication of cells, such division being ushered in by well-defined changes in the nucleus and protoplasm of the cell, mainly in the former. In the quiescent state the nucleus is composed of a fine network of threads, which readily stains and has therefore been called *chromatine*, and an intermediary substance, which does not stain, called *achromatine*. When *karyokinesis*, *karyomitosis*, or *indirect cell-division*, is about to begin, the nuclear threads and the nucleoli which are distributed in this network become more distinct and increase in size (Fig. 1538). In some of the nuclei the chromatine assumes a more granular appearance (Fig. 1539), and in others again it arranges itself in contorted filaments (Fig. 1540). In the further course of karyokinesis the threads and filaments become more and more distinct, the nucleolus disappears (Fig. 1542), as does also the contour of the nucleus (Figs. 1542, 1543, 1544). The chromatine has now become converted into separate loops, which lie in the equatorial zone of the cell with their angles converging toward the centre (Fig. 1545, 1546, 1547). Division in each loop now takes place in such a manner that a pair of similar loops results. About this time delicate threads, arranged in the shape of a spindle, have become visible in the nucleus. The ends of this spindle are called the poles, and the chromatine loops are now lying in the equator of this spindle as just stated (Figs. 1548, 1549; also Figs. 1553, 1554). The loops now begin to separate, moving toward each pole, at the same time individually changing their position, so that their angles are now directed toward the poles and not toward the centre of the cell. The result of this separation is the formation of two sets of loops, containing each about the same number of individual members as the original equatorial zone (Figs. 1549 and 1555). These gradually move toward the poles, assuming more and more the appearance of the original chromatine network, and becoming enveloped by a new nuclear membrane. And thus after its division the network of the nucleus again returns to the quiescent state.

During this last stage of karyokinesis a division of the cell-protoplasm commences as a constriction at the equator, and, becoming in time more pronounced, it finally ends in complete separation into two individual cells.

It is very probable that the nucleus is the active agent in indirect segmentation, that the properties of the cell are transmitted by it to the new cells, and that the protoplasm is responsible only for the nutrition of the latter and assists in the development of new tissues. But this cannot be asserted otherwise than hypothetically, as our knowledge of the minute changes in the protoplasm itself during karyokinesis is very imperfect. We assume that as the result of a certain activity in the protoplasm the formation of a lucid area about the nucleus occurs (Figs. 1543 *et seq.*), and also that the radiation into the protoplasm itself at the poles is due to a like cause (Figs. 1549, 1553, 1554, 1555). But the explanation of these phenomena is not yet forthcoming. For and against the vital power in protoplasm it has been asserted that fragments of infusoria, containing no part of the nucleus, are not capable of reproductive action; and also that such fragments can develop into new individuals, possessed of all the attributes of a living infusorium.

Fig. 1537.

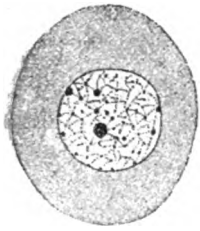


Fig. 1538.

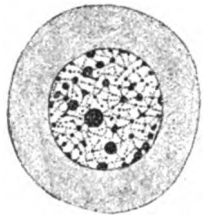


Fig. 1539.

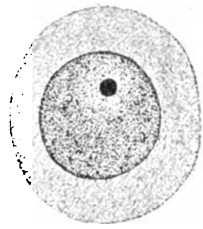


Fig. 1540.

Fig. 1541.

Fig. 1542.

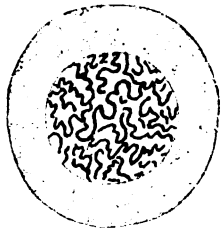


Fig. 1543.

Fig. 1544.

Fig. 1545.

Fig. 1546.

Fig. 1547.

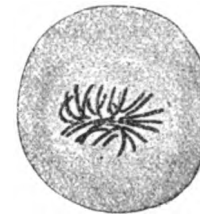


Fig. 1548.

Fig. 1549.

Fig. 1550.

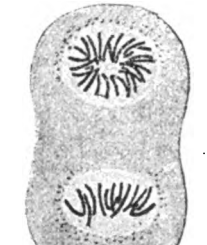


Fig. 1551.

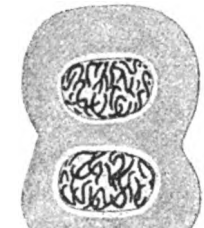


Fig. 1552.

Fig. 1553.

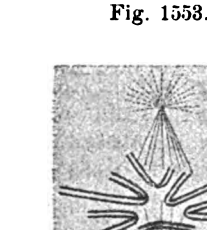
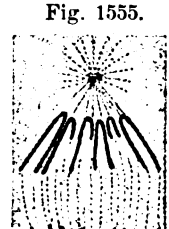
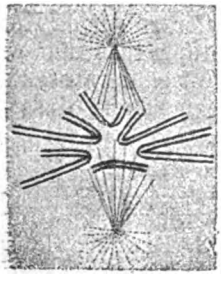
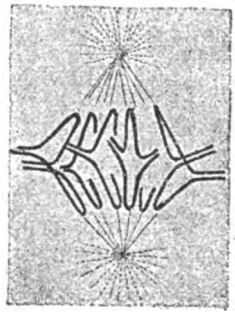


Fig. 1554.

Fig. 1555.







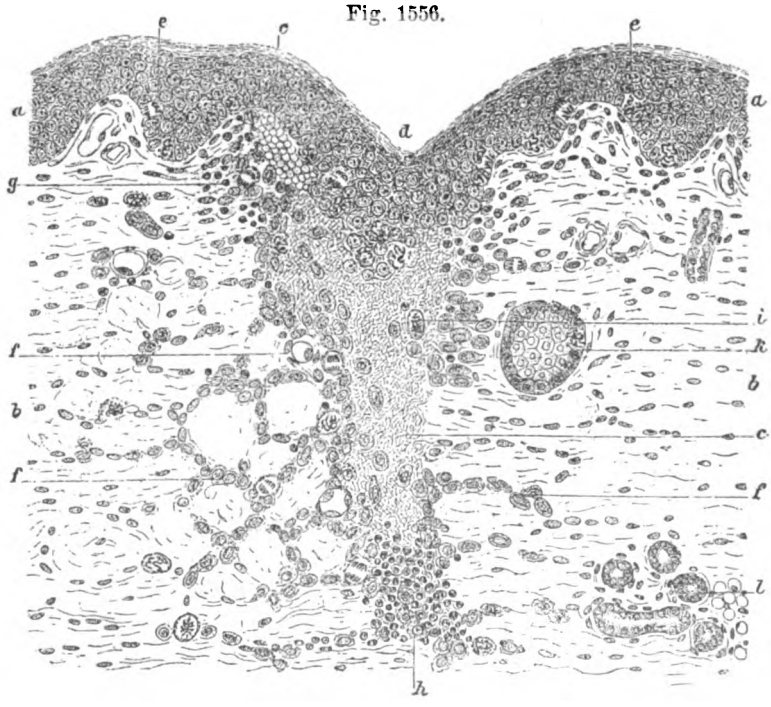
Karyokinetic Cell-Division. (Ziegler.)

In conclusion, therefore, we may say that the exact part taken by the nucleus or the protoplasm in the production of new cells has not yet been definitely determined, but that in all probability a very complicated reciprocal activity is manifested by them during this process.

DIRECT CELL-DIVISION.—Direct segmentation was formerly believed to be the only mode of cell-reproduction, before the researches of Flemming and others had brought to light karyokinetic changes in the nucleus. Now the term *direct* is restricted to that form of cell-division, during which no increase in the amount and no change in the arrangement of the nuclear chromatine is observed. It is division pure and simple, without any activity on the part of the chromatine. It agrees with this observation that direct segmentation is most frequently, perhaps only, observed in cells (leucocytes) which are destined to take no further part in regenerative and hypertrophic changes. Wherever the latter are going on, there indirect cell-division, accompanied by the corresponding nuclear phenomena, is the rule.

The immediate result of cell-division by karyokinesis is the formation of a mass of indifferent cells known as *formative cells*, or *embryonic tis-*

Fig. 1556.



Union of Incised Wound after Suture (6th day). *a*, Epidermis; *b*, corium; *c*, fibrinous exudate; *d*, regenerated epithelium partly undergoing karyokinesis; *e*, nuclear changes in cells at some distance from incision; *f*, embryonic tissue in adjacent connective-tissue spaces; some of the cells show karyokinetic changes in nucleus; *g* and *h*, leucocytes; *i*, fibroblasts; *k*, sebaceous glands; *l*, sweat glands. (Ziegler.)

sue. It is not apparent from the microscopical appearance of these cells, at an early stage, into what permanent tissues they will ultimately develop; but it is safe to say that they will only produce cells to which they are embryologically related. Thus an epithelial cell, or more cor-

rectly an embryonic cell the descendant of an epithelial cell, will never develop into connective-tissue, bone, or cartilage cells. Nor will a connective-tissue cell ever produce an epithelium.

HEALING OF WOUNDS.—When primary union is taking place, we have seen that a certain amount of granulation tissue composed of leucocytes, but mainly of embryonic cells of the connective-tissue type, is found between the wound-surfaces. Some embryonic cells also lie in the adjacent connective-tissue spaces, and they, not the leucocytes, are finally transformed into connective tissue binding the wound-surfaces together (Fig. 1556). When healing by granulation occurs, it is not so easy to observe the process of repair, and the part taken therein by the

Fig. 1557.

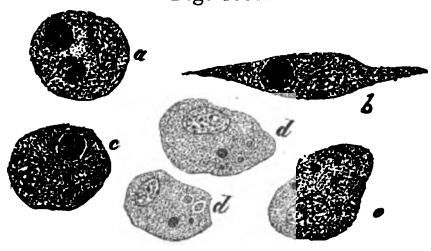
Formation of Blood-Vessels from Granulation Tissue. (Ziegler.)

fixed tissue cells, owing to the infiltration of the parts with leucocytes. The microscopical changes are, however, identical with those occurring during primary union. Embryonic cells, for the greater part derived from the connective tissue present in all the organs of the body, combine with the leucocytes that have emigrated from the blood-vessels to form a new tissue, which gradually fills up the wound cavity and is familiarly known as granulation tissue. The blood supply of this tissue comes from the most superficial capillaries in the wound surface. Here a thickening at certain parts of the vascular wall is the first intimation of the formation of a new vessel. It gradually grows in size, forming a projection, and finally a solid strand. The latter unites at its end with sprouts from other vessels, or, as is most frequently the case in granulation tissue, it returns in the shape of an arch to the vessel from which it originally sprang. It is finally converted into a hollow string

from an excavation beginning at its base, into which the blood, circulating in the original vessel, immediately penetrates, assisting by its pressure in the canalization of the entire arch.

The greater part of granulation tissue is finally transformed into connective tissue, known as cicatricial tissue, but when embryonic cells enter into the formation of granulations which are derived from other tissues than connective tissue, they will produce tissues similar to those of which they are the offspring. Thus osteoblasts will produce bone, myoblasts muscle fibres. The leucocytes in granulating surfaces are either discharged as pus, or disappear after having been absorbed by other cells in active proliferation. From all appearances this process of absorption of one cell by another (phagocytosis) must be viewed in the light of an act of nutrition, as whole leucocytes as well as fragments of their nuclei and protoplasm are found in the embryonic cells before and after cell-division has taken place. (Fig. 1558.)

Fig. 1558.



Phagocytosis. Embryonic cells containing leucocytes, etc.

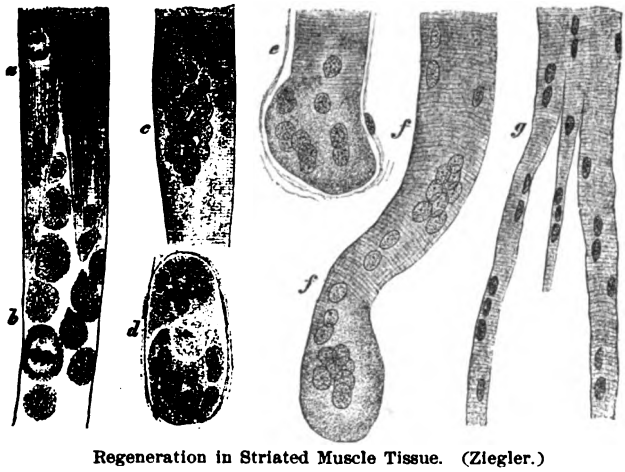
When after karyokinetic division of the nucleus the protoplasm of the cell does not divide, giant-cell formation is the result. The giant cells are found in small numbers in healthy, more frequently in tubercular and syphilitic granulations.

HEALING OF WOUNDS IN SPECIAL TISSUES.—*Epithelium.*—In granulating surfaces that have reached the level of the surrounding external tissues, the regeneration of the epithelial covering starts in from the border of the wound, or from isolated patches of epithelium lying on the granulating surfaces. All the karyokinetic changes previously described are observed in the cells undergoing division at the border line between epithelium and granulations, and a film of new epithelial cells finally spreads over the entire wound-surface. Not only surface epithelia, but also the epithelial covering of the intestinal tract and other glandular epithelia show a marked tendency to regenerate under favorable conditions. It has been demonstrated experimentally that defects in the mucous membrane of the stomach and intestines will heal very quickly, and will finally receive a new epithelial layer in which even the secreting glands have been reproduced to a greater or less extent. In this case, when healing has been rapid, it may be impossible to distinguish the site of a previous ulcer; but where wound-surfaces in the intestinal tract have been granulating for some time, and more connective tissue has in consequence been produced, the cicatrix may readily be recognized and may have led to serious functional disturbance during life. In the kidneys and liver, the glandular epithelium when lost is rapidly reproduced, provided the lesion has affected the epithelium only. On the other hand, a large loss of substance in these organs is repaired by the development of cicatricial tissue, into which a more or less perfect budding of new glands may take place from the intact glandular epithelium of the neighborhood.

Muscles.—The power of reproduction in striped and unstriped mus-

cle cells is not very great, and, although we can no longer accept the theory that wounds of the muscles always heal by the interposition of connective tissue, in the majority of such cases this appears to be true. Karyokinetic figures and consecutive cell-division have been clearly demonstrated in both varieties of muscular tissue, showing the opinion formerly held, that muscular tissue when regenerated was due to proliferation of the interstitial connective-tissue cells, to have been wrong. After section of a striated muscle the fibres bordering on the cut surfaces lose their vitality and are ultimately absorbed. The nuclei of other muscle fibres increase in number, some of them lying within the contractile tissue (Fig. 1559, *a*), others at the end of the torn fibre (*b*) within the sheath of the muscle cell. In both places karyokinetic figures are seen as early as the second day, resulting in the formation of polynuclear cells. Where the latter appear within the muscle fibre, their protoplasm is not sharply defined; there is, on the contrary, a gradual transition from it to the substance of the muscle fibre (*c*, *f*, *e*). As they increase in size in all directions they form projections at the end and the sides of the original fibre, called muscle-buds, which undergo ultimate transformation into striated fibres. Quite frequently these buds split up into a number of new fibres, which grow into the tissue, binding together the divided ends of the muscle. The polynuclear cells that have appeared as independent protoplasma masses and do not lie within the fibres (*b*, *d*), do not, it seems, take part in the

Fig. 1559.



Regeneration in Striated Muscle Tissue. (Ziegler.)

formation of new muscular tissue unless they afterwards become connected with one of the muscle-buds. The regeneration of unstriped muscular tissue follows the same law, but in man is generally very imperfect, and a loss of substance in the muscular coat of the stomach or intestine is always repaired by a development of cicatricial tissue. In lower animals, however, karyokinetic cell-division of unstriped muscle fibres has been clearly demonstrated.

Nervous System.—Regeneration of the central nervous system does not seem to occur to any great extent. Clinical as well as experimental evidence is at hand to show that wounds of the brain are only partly

closed by the development of new tissues, and that larger defects are never entirely covered. The neuroglia is no doubt responsible for the regenerative activity displayed in brain substance, as the karyokinetic changes in the nuclei of its cellular elements show. Most observers, however, agree that karyokinetic figures are also seen in the nuclei of the ganglia cells. While it is held by some that such cells do not then further divide, it is asserted by others that the later stages of karyokinesis, resulting in complete final division, can be demonstrated in the embryo in the course of development, and in the adult after traumatism.

The reparative processes after section of peripheral nerves have been most carefully investigated. After division of a nerve its distal part degenerates in all its ramifications, and is finally replaced by new fibres growing from the proximal portion into the degenerating distal end, or, at least, along the path marked out by it. This is the general mode of regeneration when the divided ends are separated from each other by some distance, however small.

Primary union in peripheral nerves, if at all possible, is certainly of very rare occurrence in man, when we take primary union in the pathological, not in the clinical sense, meaning by it an immediate union of the divided ends without degeneration. Experimental proof that the latter is not often met with is not wanting. When the sciatic nerve of the rabbit is divided only in its central portion, and the continuity of the entire nerve is, therefore, not disturbed, degeneration of the divided fibres on the distal side of the section nevertheless occurs, although it would appear that the conditions for primary union in this instance were the very best. Even clinical experience pointing to primary union of nerves must be accepted with some reserve. The return of sensibility immediately, or very soon, after section of a nerve may take place through collateral nerve branches, and a really existing paralysis of small muscles, especially in the hand and arm, may be so disguised by the combined action of neighboring muscles, that a too hasty assumption of primary union may have been made in some of the cases reported.

As regards the proximal end of the severed nerve, it is still an open question whether or not regeneration begins at the line of section, or at a little distance, one or two centimetres, above it. Even in the first instance the extreme ends of the fibres degenerate as far as the first or second constriction in the sheath of the nerve. The first microscopical changes indicating regeneration are observed in the axis cylinders, which swell and separate into several branches at their ends. The latter lie within the nerve sheaths, which occasionally also contain remnants of the old fibre. As they grow in length they perforate the sheaths and spread out in the connective tissue or endoneurium surrounding the latter. Finally they also perforate the perineurium and epineurium. The proximal end of the divided nerve is thus converted into a mass of new nerve-fibres, evenly distributed throughout the connective tissue. During this stage the new axis cylinders have also received new sheaths, most probably derived from the nerve cells lying within the old sheaths, which have begun to multiply and show karyokinetic nuclear changes. It has been suggested by some that the new axis cylinders are themselves developed from these proliferating cells. But it is more likely that the mode of regeneration from the original axis cylinder, above described, is the general one. Meanwhile the space between the ends

of the divided nerve has been filled by granulation tissue, and into this the young nerve fibres now grow. The result of their exertion to reach the distal end through the intervening tissue is dependent on the density of the latter and upon the distance which has to be travelled. Five centimetres is mentioned as the limit, but occasionally a distance of two centimetres is sufficient to prevent union, and then the ingrowing nerve fibres are lost in the surrounding tissues and do not reach the peripheral end of the nerve. But when they do meet it, the remaining nerve sheaths, containing the products of degeneration of the old nerve fibre, simply indicate the paths along which the further development of the new fibres proceeds. It is not likely that the new fibres enter the old nerve sheaths on the distal side. The majority again perforate the epineurium and perineurium, and then, continuing on their way toward the periphery, become so grouped that they more and more take on the appearance of normal peripheral nerves. The time occupied in the regeneration varies from one to twenty months.

Bone and Cartilage.—The regenerative power of cartilage is very small, that of bone very large. Loss of substance in cartilage is generally repaired by the interposition of connective tissue. The regeneration of bone has been very carefully observed during the healing of subcutaneous fractures. The production of embryonic tissue is here due to an activity in the periosteum and in the marrow at the seat of fracture. The nuclei in the cells of these tissues show karyokinetic changes a few days after the lesion, and very soon a generous formation of embryonic tissue is observed, especially from the innermost or osteoblastic layer of the periosteum. This embryonic tissue is ultimately transformed into osteoid tissue resembling in all respects normal bone tissue. The change takes place in the following manner: A homogeneous or finely fibrillated ground substance between the formative cells at first appears, derived, in part at least, from the protoplasm of the osteoblasts. Further on, this mass becomes impregnated with lime salts, and, after the disappearance of the greater number of osteoblasts, arranges itself around such as remain in lamellæ, thus assuming the microscopical appearance of normal bone tissue. The impregnation with lime salts does not, however, occur uniformly throughout all the embryonic tissue, and those parts which are not transformed into osteoid are transformed into medullary tissue. Occasionally the embryonic cells furnish cartilaginous tissue, which is also finally transformed into bone. All these various transformative processes can be observed in one and the same fracture. At the end of the second or third week the ends of the bone are united by a mass of spongy tissue lying beneath the periosteum and within the medullary canal, which gradually becomes more firm by the apposition of more osteoid tissue. We speak, at this stage, of an external, an internal, and an intermediary callus, the first two derived from the periosteum and medullary tissue respectively, the intermediate callus being considered a product of both, or, by some, of the periosteum only. This provisional callus is to a great extent absorbed during the following months, the absorption occurring simultaneously with apposition of new osseous material in other parts of the callus. Absorption and apposition follow certain laws and do not occur at random. The former takes place at those points at which, from the nature of the displacement always present to

a greater or less extent, new bone is not needed; the latter where greater firmness is required—at those points of the callus through which, for example, the weight of the body is transmitted. In most cases of fracture the continuity of the medullary canal is ultimately restored as a result of absorption in the callus, even when the displacement has been considerable.

II. Wound-Treatment.[1]

The technique of wound treatment has, during the last ten or fifteen years, become more complicated by the general adoption of the antiseptic system. Much detail work has become necessary, the exact performance of which is alone a guarantee of good results. It matters not, however, how great the changes in the practical application of the method, first described by Sir Joseph Lister, have been during these years, the great principle involved in it remains unchanged. It is owing to this fact that the older methods of wound-treatment have at last become obsolete, and that the advocates of the open method, of the treatment by occlusion, and of other similar methods, who were for a long time opposed to the antiseptic principle, have disappeared. The theory, if not the practice, of wound treatment has, therefore, certainly been simplified. Whatever may be the nature of wounds, whether they be incised, contused, lacerated, or punctured, whether they be surgically clean or infected, the principle that primary or further infection must be avoided during our manipulations will always obtain. Great, indeed, have been the modifications in the original "aseptic method" of Lister during the years since its publication. They have been brought about by a correct recognition and a further development of the great principle involved. On a sound theoretical basis, progress in the practical application of a method must be rapid and systematic, and, accordingly, the advance made in the treatment of wounds during late years forms a marked contrast to the many attempts at rational treatment before the days of universal acceptance of the germ theory as the cause of all surgical ills.

When Lister first published his new method he termed it the "aseptic method," to distinguish it from the other methods then in use, such as the open treatment of wounds, the treatment by occlusion, and the treatment with antiseptics,[2] which were included among the "antiseptic methods." Even at that time it had been abundantly proven that the older plans owed their successes to some antiseptic measure of which they were the unconscious exponents, and many of their failures to a lack of uniform application of the antiseptic principle. Thus, for instance, the open treatment, by permitting the free access of air, or more correctly of the oxygen therein contained, to wound surfaces, prevented fermentation, and by furthering evaporation and concentration of the secretions, retarded the growth of almost all forms of micro-organisms. But the opportunities for infection from other sources were so many that the good effects of these measures were simply a matter of chance, and did not become apparent with any degree of certainty. In those days the

[1] For the classification of wounds and their special treatment, see Mr. Bryant's article on Wounds, in Vol. II.

[2] See Vol. II., p. 42.

"aseptic method" of Lister stood forth in bold relief against all these others, and it cannot be too frequently insisted upon that it was the first based in all its particulars upon the germ theory of infection, and consequently the only method which, in a systematic way, sought to prevent the entrance of micro-organisms into wounds. In the course of its further development it has come to pass that the words "antiseptic" and "aseptic" are used in a somewhat different sense from that which they at first imparted. Other methods than those based on the antiseptic principle are now no longer recognized. There are two ways of rationally applying this principle in wound-treatment. Following the one, we attempt to destroy all living germs deposited on instruments, upon the hands of the surgeon, the dressings, and other articles that are brought in contact with wounds, by subjecting them to sterilization by heat or chemical agents. When this has once been thoroughly accomplished, the further use of antiseptics is discontinued, and care is especially taken that these are not brought in contact with the wound itself. Such methods are termed *aseptic*. When, however, we continue the use of chemical germicides during operations by irrigating the wound surfaces with antiseptic solutions and by immersing our hands in the latter, when we employ dressings impregnated with them, and when during the further treatment we take similar precautions, we are employing "*antiseptic*" methods. The first is certainly the ideal form of wound-treatment. If we can accomplish the same by both, that method which does away with the irritating effects of strong antiseptics upon wound surfaces deserves preference.

It follows from what has been said that we would to-day include Lister's original aseptic method among our modern antiseptic methods. It will be of interest in this connection to follow the changes which have taken place in the latter until the systems in use to-day have been developed. Not many years after Lister's publications, attention was called to the great inconvenience of the spray during operations and the application of dressings. So great had been the improvement in the results of wound-treatment since the Listerian method had been adopted, and so firm had the belief in all its details become, that it seemed a hazardous proceeding to discard one of the latter, deemed by its inventor of the greatest importance. Lister's method, was based on the assumption that infectious germs were everywhere suspended in the air, and that it was necessary, in order to render them harmless, to destroy them by some antiseptic in the shape of spray, before they should fall upon wound surfaces. When the great drawbacks of the spray, the drenching of both patient and surgeon, the interference with close observation on the part of the latter, and particularly the cooling off of the patient during certain critical operations, became apparent, the question of its real worth was more critically approached, and experiments were made to test the efficacy of the spray in preventing the entrance of active germs suspended in the air into sterilized culture tubes. While these demonstrated that some influence was undoubtedly exerted upon the growth of germs which had passed through a cloud of spray, they also showed that the vitality of these germs was not entirely destroyed. About at the same time Trendelenburg, and also Bruns, had found that the results of antiseptic treatment were equally good, whether the spray was used or not. Now it is a well-established fact

that after rain the atmosphere contains fewer micro-organisms than before it, due in part to precipitation of the floating matter to the earth. The spray acts in a similar manner. It carries along the impurities in the air and deposits them upon the wounds, and it thereby apparently adds an element of danger to the method. In one way, however, it proves efficient. It keeps the wound surfaces covered by a thin layer of antiseptic fluid, which is in reality the equivalent of continuous irrigation. That the real value of the spray was due to this factor, was recognized by those who advocated its discontinuance, and it was by their efforts that it was gradually superseded by frequent irrigation of wounds, as a part of the antiseptic system. As we have said, the results following this change were in no wise altered for the worse. It stood to reason that thorough irrigation, occasionally resorted to during the progress of an operation, would be more effective in removing particles that had settled on wound surfaces and were but loosely attached to them, than the spray.

During the last few years a great deal of time and labor has been spent in determining the nature and the number of germs suspended in the atmosphere. A given quantity of air has either been passed through a long tube coated with some culture medium upon which the germs are deposited during its passage, or such culture media have been liquefied, and the air has been forced through them in appropriate vessels, where, after solidification of the media, the germs develop as individual foci, and can easily be counted. More recently still, air has been filtered through sand, which is then mixed with the medium with a similar object in view. With the assistance of these methods it has been shown that the number of suspended germs varies greatly with the locality in which the experiments are made, with the disturbed or quiet condition of the atmosphere, and with the amount of moisture deposited on the surrounding objects. I have already referred, in proof of this assertion, to the fact that after rain has fallen the atmosphere contains fewer particles in suspension than before. Petri, who examined the sewer-gas of Berlin at several points of the subterraneous canal, found scarcely any micro-organisms in the air. It can, furthermore, be easily demonstrated that samples of air taken from one and the same room contain more germs after the dust on the floor and the walls has been stirred up, and that these additional germs again settle down very rapidly in a few hours, if allowed to do so. Lastly, if really a practical demonstration of such a fact is necessary, it has been experimentally shown that moistening floors very materially interferes with the raising of dust-particles, and consequently of germs, into the atmosphere, and that even the strongest currents of air passing over liquids which teem with unknown numbers of micro-organisms, are unable to carry away in suspension any of the latter. All these data have been turned to advantage in the development of the aseptic system, and I shall refer to them again. They show the varying numbers of germs. But it is of even greater importance to ascertain their nature. In this respect it is very gratifying to the surgeon to know that very few pathogenic germs have been discovered in the air. Fungi and non-pathogenic bacteria are the varieties generally found in suspension. It is true that in the air of hospital wards the number of the former is somewhat increased, and it would not be wise, therefore, to disregard entirely

their presence. We can understand that in such operations as the opening of large joints or the cranial cavity, even the entrance of very few germs might be the source of much mischief, and it will not be amiss, on this account, to avoid increasing the number already in suspension by unnecessary manipulations in the operating room shortly before an operation. If we take this precaution, we may safely disregard the possibility of infection from this source in all surgical work.

It has been estimated that about sixty or seventy germs are deposited upon a wound surface of sixteen square inches, in the course of half an hour, at von Bergmann's Clinic, in Berlin, during the clinical hours. Remembering how few of these are pathogenic, and remembering also the power of healthy tissues to inhibit the development of germs, especially when present in small numbers only, the relative insignificance of their presence will become apparent. The dangers from this source are small when compared with those that threaten from infection when imperfectly sterilized instruments and hands are brought in contact with wound surfaces. A minute quantity of pus in the furrows of a forceps, or under the nails of the operator, may contain many thousands of germs, and very likely of the pathogenic variety. It is further evident that the probability of an infection is greater when impure objects are introduced and brought into frequent and close contact with wound surfaces, than when a few germs settle very superficially on the latter. The most important factor in wound-treatment is, therefore, the avoidance of contamination by *direct contact*. All improvements in our methods must be based on this one consideration: how to render aseptic in the most convenient manner all objects which come in contact with wounds.

Disinfection of Hands and Field of Operation.—In 1882, Watson Cheyne wrote: "It is unnecessary to wash the skin with soap and water, or with alcohol or ether, as is often done in Germany." This applied to both the hands of the operator and the seat of operation. Cheyne assumed that the affinity of carbolic acid for the skin caused it to penetrate the latter, where it would then destroy the germs lying in the folds and the grease of the epidermis. Although such an opinion was expressed by one most competent to judge, I think we shall not err in assuming that even at that time most surgeons began the disinfection of their hands and the seat of operation by a thorough washing with soap and water, before submitting them to the action of an antiseptic. It was, nevertheless, the opinion then held that a thorough rubbing with a 1–20 or 1–40 carbolic solution was more effective than washing with soap and water, whereas to-day we are ready to assume the reverse. In 1885, the experimental method was for the first time applied to determine the germicidal power of various antiseptics after thorough washing with soap and water. Carbolic acid, boric acid, corrosive sublimate, and other disinfectants were tested by Forster in these experiments with culture-media. He came to the conclusion that corrosive-sublimate solutions alone prevented the development of germs. Shortly afterwards Kümmel, and somewhat later Fuerbringer, repeated these experiments in a more satisfactory manner. They directed attention to the folds and fissures of the skin, and more especially to the subungual space, as places which harbor impurities,

and they also showed how difficult a task it was to dislodge the latter by mechanical means. It was a notable fact, which Kümmel first observed, that the same method of cleansing and sterilizing his hands would not in one instance interfere with primary union of wounds, but would invariably in another lead to the development of at least a few germs in the culture-media. We may very correctly conclude from this that not all the germs upon our hands are pathogenic, and also that the living tissues under normal conditions can prevent their further development. The question, whether or not sterilization of the hands soon after their contamination with septic material is possible, is one of grave importance to the surgeon and obstetrician. Kümmel came to the conclusion that under ordinary circumstances a thorough cleansing with soap and water, followed by immersion and rubbing in a 6–1000 solution of thymol, a 1–1000 solution of the bichloride, or a 3–100 solution of carbolic acid, was a sufficient guarantee for all practical purposes. In order to prevent with absolute certainty any development in culture-media, however, it was found necessary to use a 5–100 solution of carbolic acid, or a mixture of equal parts of chlorine water and water. But, when the hands had been infected at the post-mortem table, or by a septic wound, then the above method was not sufficient to accomplish complete sterilization, and this was only attained after washing the hands for five minutes with soap and water, and then for two minutes in the chlorine-water solution.

To Fuerbringer undoubtedly belongs the credit of having first called the attention of surgeons to the necessity and the difficulty of thorough disinfection of the fingers in the vicinity of the nails. Even after most careful application of the then known methods of disinfection, Fuerbringer was always able to obtain cultures from scrapings taken from beneath the nails. The result of his researches was that much more effective sterilization was possible, when the hands after cleansing with soap and water were immersed in alcohol, before an antiseptic was applied to them. He gives the following as the best mode of disinfection: After thorough mechanical cleaning of the nails, which ought always to be cut very short, the hands should be washed for one minute with soap and water; then for one minute more in alcohol (not less than 80 per cent.); then the alcohol is allowed to evaporate and the hands are immersed in the antiseptics (3–100 carbolic acid or 2–1000 corrosive-sublimate solution) and washed well for another minute, using sterilized nail-brushes for all these manipulations. Some doubt has been expressed as to the efficiency of alcohol, and it has been asserted that it makes the skin brittle and deadens sensation. These exceptions do not, however, appear to be well taken, and it must be regarded as an idiosyncrasy if alcohol so unfavorably affects some hands, something that is true of other disinfectants to a much greater extent. The different effect of carbolic acid and of sublimate on the skin of different individuals is too well known to need repetition. Geppert has shown that chlorine is one of the most powerful germicides, and consequently recommends it for the disinfection of hands. A paste containing chlorinated lime is rubbed into the hands, and these are then placed in a 2-per-cent. solution of hydrochloric acid, where they remain for two minutes, until the separation of chlorine ceases. They are then washed in a solution of hyposulphite of sodium, and finally in sterilized water. This method,

although adopted by a few, has never found general favor. It is very efficient, but rather complicated.

Others have recommended that the hands should be rubbed with glycerin or lanolin as a preliminary measure to sterilization, in order to soften the epidermis and make disinfection more effective. It does not seem that this plan has much to commend it. Kelly has lately described a method of hand-disinfection, based upon experiments, for which he claims superiority over the methods of Kümmel and of Fuerbringer. It is the following: The hands are scrubbed, with especial attention to the nails, in water of 104° F., which is frequently changed. They are then immersed in a solution of permanganate of potassium, made by adding an excess of the salt to boiling distilled water, until they are mahogany or black in color, when they are thrust into a saturated solution of oxalic acid until completely decolorized. The oxalic acid is finally removed by washing in distilled water. This method has been improved upon by immersion of the finger-tips, after the oxalic acid treatment, in peroxide of hydrogen, followed by a bath of the whole hands for three minutes in a solution of corrosive sublimate, 1–1000.

Mikulicz thinks a combination of antiseptics more powerful than one alone. After cleansing the nails carefully, he washes the hands for three minutes with soap and water; then for half a minute in a 3–100 solution of carbolic acid, and finally in a sublimate solution, 1–2000. For laparotomies the strength of the carbolic lotion is raised to 1–20. The skin about the nails, more especially the subungual spaces, are rubbed with 10-per-cent. iodoform gauze, which has been moistened in 5-per-cent. carbolic acid.

From all this experimental work, it will be somewhat difficult to select the safest and, at the same time, most convenient method. Several points have, however, been made clear by these investigations. It is insufficient to simply wash our hands in soap and water, even if this be repeated several times, giving them a final ablution in sterilized water. On the other hand, thorough washing with soap and water is the most important phase of disinfection. Not all hands permit of thorough disinfection with the same ease or difficulty. After each operation the surgeon should wash his hands with soap and water before again disinfecting them with an antiseptic, previous to further surgical manipulations. Infected hands are more difficult to sterilize than hands which have not been in contact with infectious material for some time. Of all the methods, Fuerbringer's seems to give sufficient guarantee of complete disinfection and to be the most simple in its application.

Other parts of the body are less difficult to sterilize, if we except the cavities of the mouth, nose, rectum, and vagina, which cannot be rendered aseptic. To prepare a patient for operation, a bath, or a prolonged washing of the seat of operation with soap and water, if the former is out of the question, ought to be given some hours before, and the part should be shaved, not with a view of removing only the hairs, but also the superficial layers of epidermis, which enclose myriads of germs of every description. To assist in removing gross impurities the skin may now be rubbed with ether or alcohol, preferably, in my opinion, with the former. Next they should be covered with a moist antiseptic dressing (bichloride, 1–1000) which is only to be removed on the operating table.

It is a vain attempt to sterilize mucous surfaces, even the vagina, which is most accessible. If this were possible, other considerations should here prevent the use of strong antiseptics, namely, their irritating qualities and the readiness with which they are absorbed. The use of warm water and soap, and of frequent irrigations with sterilized water or Thiersch's solution, are the safest and most effective methods of cleansing mucous membranes prior to operations.

Great care should be taken to have the brushes, used in disinfecting hands and skin, in an aseptic condition. New brushes should be cleaned with soap and water and then boiled for a few minutes. They are then placed in a 1–2000 sublimate solution, and are kept there until used. When they have been once soiled—in cleaning the hands, for example, after operations in septic cases—they should again be carefully disinfected, which can only be accomplished by boiling them. Wooden brushes will stand repeated boiling for a few minutes, for some time. It should not be omitted, as simple disinfection with antiseptics has been experimentally proven inadequate to the removal of septic matter from between the hairs of the brush. It has been asserted that sterilization with boiling water or steam is sufficient, and that it is unnecessary to keep brushes in antiseptic solutions. In hospital practice it is certainly wise to do so. We are sure of one thing: in the solution they will remain aseptic until used.

Sterilization of Instruments.—Instruments can be sterilized by immersion in antiseptic solutions, or by heat. The former was universally adopted until it became evident that the latter possessed many advantages. The first advance upon the plan of Lister, by which instruments were simply placed in a trough containing a carbolic solution, 1–20, was a recognition of the fact that in this instance, also, mechanical cleansing was a most important part of the entire process of sterilization. To facilitate this as much as possible, care is now taken in the manufacture of instruments to avoid all uneven surfaces, indentations, and furrows. Smooth metal handles, and instruments made of one piece of metal, are now used in preference to those with wooden handles. If these are carefully brushed and washed, they are well-nigh sterilized by this procedure alone, especially when subjected to an additional rubbing with ether or alcohol. If they be next placed for one minute in either a 1–20 solution of carbolic acid, or a 1–1000 solution of sublimate, they will give no cultures when thrown into culture-media. But if they have not been subjected to the mechanical procedures above detailed, an immersion of from at least ten to fifteen minutes in antiseptics will be necessary to attain the same end. Here I must give a caution against implicit faith in these culture-tests. Some of the antiseptic, still clinging to the surface of the object brought in contact with the media, may prevent the development of germs that have not been removed by the process of sterilization. We have seen that their value in determining absolute sterilization of the hands is also doubtful. If we can sterilize by heat, this plan is, therefore, always to be preferred. It is impossible in the case of our hands, but it is really surprising that it should have taken so long to establish this procedure as the only rational one for the sterilization of surgical instruments, when it had long been employed for a similar purpose in bacteriological

laboratories. Dry sterilization of instruments was at first tried, from a desire to prevent rusting. The disinfecting power of dry heat is far below that of moist heat, but this deficiency, it was believed, could be fully made up by a higher temperature. A number of apparatuses, in which instruments could be heated to 150–180° C., were now constructed. But many drawbacks to this mode of sterilization became apparent, as it was more frequently employed. Just what it was sought to avoid occurred; when heated to a high degree, instruments became rusty during cooling. The temper of the metal also became seriously affected. Steel lost its hardness and, as a result of this, cutting instruments became dull. But the main objection to the method is the time which it consumes. It is not an easy matter to raise a metal sterilizing oven to an even temperature of 150–180° C., and after rapid heating widely varying temperatures may be registered at different parts of the apparatus.

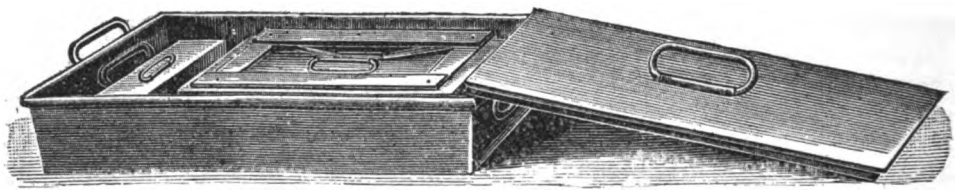
All these disadvantages connected with dry sterilization were influential in stimulating investigation in the direction of the application of moist heat for sterilization of instruments. Rédard found that steam under pressure at 110° C. absolutely sterilized instruments in from ten to fifteen minutes, but that sterilization by boiling liquids could only be accomplished at a temperature of 120° C. He made many attempts at compounding a liquid "which should boil at 120° C., should be cheap, not poisonous, and not inflammable, should not emit any odor during ebullition, and, above all, should not harm the instruments." He experimented with glycerin, olive oil, and castor oil, but found these unsuitable for his purpose. He ultimately decided upon a mixture of forty parts of calcic chloride and sixty parts of water, which boils at 110° C. But Rédard did not turn these results to any further practical use, believing in the superior efficacy of steam, on which principle he constructed a somewhat complicated apparatus. Many other apparatuses for sterilization by steam have also been constructed, but, as the method has now been generally abandoned, I will not mention them.

It appears that Davidsohn, a pupil of Robert Koch, first emphasized the advantages of sterilization by boiling, but to Schimmelbusch belongs the credit of having definitely introduced the method into surgical practice, after a series of experiments in von Bergmann's Clinic, which demonstrated its simplicity and at the same time its efficiency. Instead of pure water Schimmelbusch recommends a 1-per-cent. solution of plain washing-soda. This has a double purpose. It intensifies the sterilizing power of boiling water by removing grease and dirt from the surface of instruments, and it absolutely prevents rusting. Instruments of proper construction, that is, with smooth surfaces, when thoroughly clean, can be sterilized by boiling for only five minutes in such a solution.[1] It is quite immaterial whether instruments are boiled in special apparatuses or simple enamelled dishes or pots. In private practice the simpler a surgeon's outfit the better, as long as the instruments are sterilized immediately before operation. It does not seem a wise procedure to sterilize instruments at home, to convey them to the patient's house, and to assume that everything has been

[1] Care should be taken to secure the necessary concentration of the soda-solution (one per cent.), as otherwise the instruments will suffer; and it is well to remember that commercial soda is frequently adulterated to a large extent with ordinary salt and other ingredients.

done to guarantee perfect asepsis. This is the practice of some well-known surgeons. I do not contend that it is impossible to have absolutely clean instruments by this process, but the necessary manip-

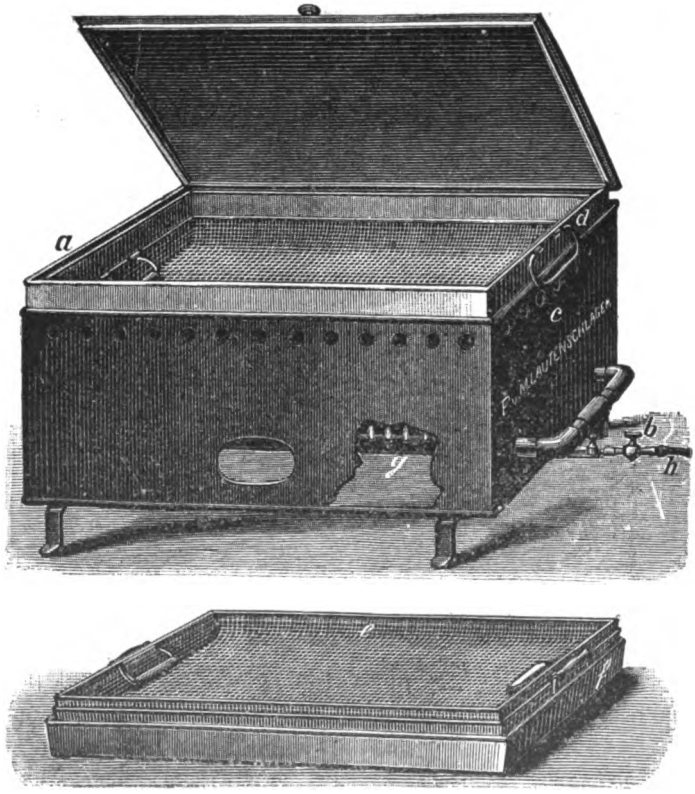
Fig. 1560.



Rotter's Portable Sterilizer for Instruments.

ulations in drying and packing them away certainly add an unnecessary element of danger. And there is no analogy between instruments and dressings in this regard, as the latter can be transported in the very vessels in which they are sterilized, which need only be opened at the operation itself. It would be useless to enter upon an enumeration of

Fig. 1561.



Schimmelbusch's Sterilizer for Instruments.

ordinary commercial articles that may be used in the boiling of instruments. A very good and simple way is to boil them in an enamelled pudding-dish, using a similar dish, inverted, as a cover. Then,

after they are boiled, the surgeon needs two sterilized dishes for use during the operation. A compact apparatus for private practice has been described by Rotter. It is about three inches deep and a foot long, and contains three metal boxes with covers of various sizes, a folding stand, and an alcohol lamp. In using the apparatus care should be taken to make the soda solution with very hot water, so that it can be raised to the boiling-point in a very short time. It is safer to allow the alcohol to burn away, rather than attempt extinguishing it with the cover, and with a little experience it is easy to estimate the amount of alcohol necessary to keep the solution at the boiling-point for five or ten minutes. Other apparatuses have been devised of late for the simultaneous sterilization of instruments and dressings, but separate sterilization is preferable.

For hospital-work, the large, non-portable sterilizers, which are heated by gas, answer a better purpose, as they can be kept heated and thus insure rapid sterilization of instruments between operations. With few modifications the idea of Schimmelbusch's apparatus has been retained in their construction. This apparatus consists of a metal box (*c*) into which the soda solution is poured, one inch deep. Into this box, which is closed by a lid, perforated trays (*e*) can be placed, which hold the instruments to be sterilized. They are introduced into the apparatus as soon as the water begins to boil, and are allowed to remain for five minutes. They are then removed from the box by the wooden handles at each side, and are placed in a pan (*f*), which is filled with cool sterilized soda solution. The pan has also been previously sterilized in the apparatus. The lid of the box fits into a groove (*a*) whch is filled with water, and thus closes hermetically. This prevents evaporation during ebullition, and raises the temperature of the solution to 104° C.

SPONGES AND MOPS.—Much difference of opinion seems to prevail in regard to the difficulty of rendering sponges aseptic. Some surgeons, notably Kümmel, have considered this a very easy task. Kümmel says that when sponges have been thoroughly washed with warm water and soap for three or four minutes and are then placed in either a 5-per-cent. carbolic-acid solution, in chlorine water, or in a 1–1000 sublimate solution for one or two minutes, they will be disinfected with absolute certainty. But, in view of other testimony, this can no longer be accepted as true. The quality of a sponge has, doubtless, much to do with the ease with which it can be rendered aseptic. If in the process of preparation the sarcode, or gelatinous material, which covers the sponge and has fully penetrated its framework, is entirely removed, the antiseptics can more readily come in contact with all parts of the latter. In this respect it has been demonstrated that a dense-textured sponge is more difficult to sterilize than one with a wide meshwork. The latter are cheaper, but have the disadvantage that loose pieces are frequently attached to their surface, a defect which becomes more noticeable with continued use. It is advisable, therefore, to use an open-textured, cheap sponge, but to use it only once. Neuber uses sponges in this way, but also includes them in the dressings of the case in which they have been employed. It is regrettable that sponges are so unfavorably influenced by heat. It is true that dry

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heat will sterilize a sponge in a few hours, but, if great care is not taken to have the sponge perfectly dry, it will shrink and become hard. The same objection can be urged against boiling them, which causes them to assume a dark-brown color, to shrink very much, and to lose most of their absorbing power, and when dry they will become perfectly hard.

Absolute sterilization is, therefore, owing to the structure of the sponge, impossible. But we can come very close to perfection by careful preparation. Sponges should be well beaten, to free them from sand and other gross impurities. They should then be placed and remain for some time in cold water and be repeatedly manipulated, to free them from any further impurities. If it then seems desirable to bleach them, this is most readily accomplished by immersion for a few minutes, first in a solution of permanganate of potassium (one ounce to two quarts of water), and then in an oxalic-acid solution of the same strength. They are now washed in water and are ready for disinfection. For this it is not sufficient to place them for a short time in either a 5-per-cent. carbolic or a 1–1000 sublimate solution. They should remain in one of these solutions, preferably the latter, for several days. Before being used they are put in sterilized water. Schimmelbusch recommends that before being thrown into the antiseptic solution, they should be immersed for half an hour in a 1-per-cent. soda solution, which has been raised to the boiling-point, but which has been removed from the fire before the sponges, wrapped in a cloth and wrung dry, are suspended in it. If sponges must be used a second time, they ought to be carefully cleaned, to free them from the fibrin which they have taken up, and which is only removed from the meshwork with much labor. It still seems that Lister's plan of placing the sponges for some days in a tank containing water, thus allowing the fibrin to decompose, when it can be easily removed, is one of the best. Then they may again be sterilized as new sponges.

In most operations, we can, however, discard sponges altogether, and the substitution for them of small pieces of gauze, or of several layers of gauze sewed together in the shape of a flat sponge, or of cotton sewed into a small sack of gauze, has of late become very popular among surgeons. All these are sterilized by steam, as I shall hereafter describe in speaking of dressings. The small sacks containing cotton are thrown away after being used, but the pieces of gauze can be readily cleaned and re-sterilized. They become rather softer after frequent use, and absorb more readily, and can very conveniently be folded together in any way to suit the occasion. They can be held by dressing forceps, and thus may be used to mop up deep cavities with as much ease as sponges. The most convenient size seems to me from experience to be about eight inches square. The only drawback to their employment is the rather large supply of them which a major operation necessitates. They ought to be used dry, and not moistened with antiseptics, and in consequence thereof they must be laid aside when once saturated with blood or other fluids.

ASEPTIC LIGATURES AND SUTURES.—The materials generally used for this purpose are catgut, silk, silver wire, and silkworm gut. Wire and silkworm gut are readily sterilized by boiling, as they are both imper-

meable to moisture. It will, therefore, suffice to boil them before every operation during five or ten minutes in a 1-per-cent. soda solution, as has been recommended for the disinfection of instruments, and to preserve them, when once they are aseptic, in absolute alcohol until used. This will prevent them from becoming contaminated with germs that might resist the sterilizing effect of boiling when this has been limited to only five or ten minutes.

The sterilization of *catgut* and *silk* is a much more difficult undertaking, more especially the preparation of aseptic catgut. Only a few years ago it seemed as if we should be compelled to entirely abandon the use of the latter, so utterly impossible was efficient sterilization by the then known methods believed to be. But we are now fortunately convinced of the contrary. It was undoubtedly an advance in the preparation of gut, when Kocher described his method with juniper oil, in which he placed the raw material for twenty-four hours before preserving it definitely in 95-per-cent. alcohol, and this mode of preparation soon replaced those recommended by Lister for carbolized and chromicized catgut. The new gut was extensively used, until it was shown by scientific methods that the procedure by which it was prepared was quite incapable of producing an aseptic material. Catgut is absorbable, and for this reason it is almost indispensable in surgical practice. It is precisely this quality, however, which increases the difficulty of its sterilization. During the manufacture of the raw material from sheep's gut, where no precautions whatever are taken, it is evident that many impurities may find their way into the substance of the threads, if they are not already present in the substance of the gut from which the threads are twisted. It is not improbable that a case of anthrax infection from catgut, reported by Volkmann, was due to the presence of spores of anthrax within the substance of the thread. Other germs imbedded therein may also, as the catgut becomes absorbed in the living tissues, be liberated, and, if still active, may develop, and cause all the symptoms of wound infection. It is customary to grease catgut during its manufacture, to render it soft and less brittle. This answers an excellent purpose for the manufacture of musical strings, but it ought to be strictly avoided when making surgical catgut. This greasing has led to the necessity of placing the gut in ether before further subjecting it to disinfection by chemical aids. The fatty substances are thus extracted, which is important, as they form a very potent barrier to the penetration of watery solutions.

When it was shown that juniper oil did not possess sufficient antiseptic power, the bichloride of mercury came into use some years ago, and it is still to-day acknowledged to be by far the best disinfectant for this purpose. Corrosive sublimate has been used in watery and alcoholic solutions for the preparation of catgut. Von Bergmann uses alcoholic solutions at the Berlin Clinic. His method of preparation is the following: Surgical catgut is wound on glass reels or plates, and placed in ether for twenty-four hours, and then for at least forty-eight hours in a mixture of 10.0 parts of corrosive sublimate, 800.0 parts of alcohol, and 200.0 parts of distilled water, the same being changed every twenty-four hours until it no longer becomes turbid. Then sterilization is said to be complete, and the catgut may be indefinitely preserved in ordinary alcohol of 95 per cent. It is not quite certain

that this procedure is a guarantee of absolute sterilization. Experiments by Braatz have shown that spores of anthrax, adhering to the external surface of catgut, can remain in this alcoholic sublimate solution for four days and not lose their vitality, but that cultures can no longer be obtained when such threads have been suspended in a watery solution of sublimate, 1–1000, for only twenty minutes. There is, therefore, no reason for the preparation of catgut in alcoholic solutions, if there are no other disadvantages attaching to the use of watery solutions. It is true, the textile strength of the gut is considerably affected by aqueous solutions of sublimate, much more certainly than by strong solutions of sublimate in alcohol. This is, however, of minor importance when compared with the question of thorough disinfection. Even if, by the method to be presently described, we produce catgut that occasionally tears, the additional labor during an operation on this account is hardly worth considering. On the other hand, when freshly prepared catgut has lost some of its strength, we may rely on its having been pretty effectively sterilized. The surest mode of chemical sterilization, therefore, is the immersion of the gut, after it is taken from the ether, in a 1–1000 aqueous solution of sublimate. It is important that the antiseptic should have uniform access to every part of the gut. If the coils of the latter are tied together with threads, these ought to be very loose, or otherwise the gut, swelling as it imbibes the sublimate solution, will be constricted at these points and not properly disinfected there. The gut remains in the solution for twelve hours, the fluid being renewed once or twice during this time. Kümmel believes that six hours for the finer, and twelve hours for the coarser qualities, will effect certain sterilization. If the gut is not wound on reels, which is a better plan, it will curl in the sublimate and will finally form a much-entangled mass of threads, from which, however, the individual threads may be drawn without much difficulty, and may then be wound on sterilized glass reels or plates. Then the gut is placed in absolute alcohol.

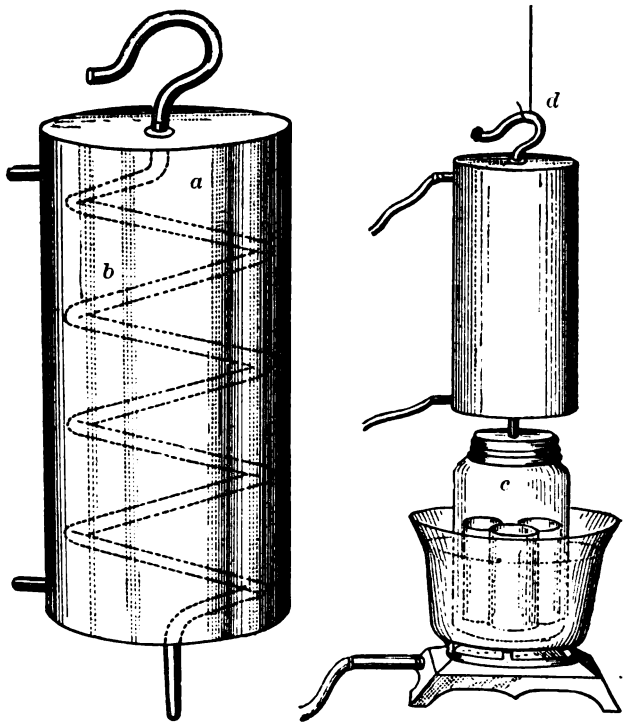
Sterilization by heat, as everywhere else in the aseptic system, has also been applied to catgut, but in this instance with only moderately satisfactory result. Boiling water and steam in a few minutes convert gut into a shapeless, glutinous mass. After boiling in oil or glycerin the gut becomes very brittle, and too much of its strength is sacrificed. Xylol, the boiling point of which is 130–140° C., is recommended by Brunner, who states that catgut may remain in it, when heated to 100° C., for many hours without losing any of its essential qualities, and that this is more or less the case when the temperature is raised to the boiling point of xylol. This method would answer well if we could assume that the gut was sterilized by this procedure, but such does not seem to be the case. It is a well-known fact, which applies also to xylol, that oily antiseptic mixtures possess little disinfecting power when compared to watery solutions, because they cannot penetrate as well. Another fluid has, however, been employed lately, and, as it appears, very successfully, for boiling catgut, namely alcohol. Boiling alcohol possesses very marked germicidal power. It will more readily destroy the most virulent germs without injuring the quality of the gut than any other antiseptic solution. It rather increases the textile strength of the gut, and it makes it less slippery. It further-

more extracts the grease, which in the process of twisting has got into the interior of the strands. Fowler and Hodenpyl assert that boiling in 95-per-cent. alcohol will sterilize catgut in one hour. Supported as this method is by experimental proof of its efficacy, it would certainly have been more rapidly accepted by the profession, were it not that the boiling of alcohol is attended by some risk and inconvenience. Fowler lately recommends boiling under pressure. His method is the following:—

The catgut is cut into lengths, folded, and placed, half a dozen strands or more, in an ordinary four-inch test-tube. This is filled with 95-per-cent. alcohol to within half an inch of the top, and a wad of cotton is pushed into the mouth of the tube, and over this a cork is so placed as to be upon a level with the edge of the tube when its lower end rests against the cotton. Thus prepared, the tubes are placed inverted in a fruit-jar filled with alcohol of a percentage not lower than 95, and the jar is then hermetically sealed and placed in a water-bath. This is heated to slow boiling, and is kept at this point for one hour. The jar must be allowed to cool before being opened. Upon removing the tubes containing the catgut, each one is carefully sealed over the cork by a layer of silicate of sodium.

Fowler's recommendation of boiling in alcohol has been tested in many New York hospitals and has given entire satisfaction. The disadvantages of his method are evaporation of the alcohol, which is difficult to prevent, even in tightly closed vessels, and occasional exposure of the gut to a temperature of 90–95° C., which, if sustained for an hour, is liable to injure the material. Dowd for this reason suggests the use of a condenser of copper (Fig. 1562, *a*) in which lies a coil (*b*) wherein the vapors of alcohol are condensed, returning to the glass jar (*c*) which contains the boiling alcohol. This jar is suspended in a water-bath by means of the end of the coil, which is shaped into a hook (*d*). The water is heated to such a degree only as will insure boiling of the alcohol. The open end of the hook is plugged with cotton. Within the jar (*c*) are placed three small cylindrical screw-topped jars (*e*), which in turn hold the catgut, wound on three reels. These smaller jars are also filled with alcohol, and their

Fig. 1562.

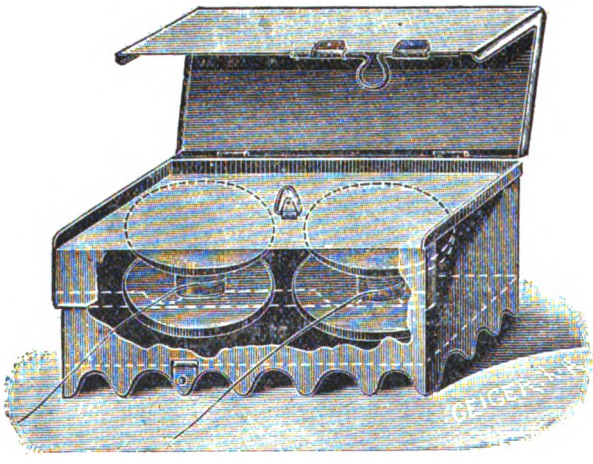


Dowd's Sterilizer.

covers, fitted with rubber washers, are screwed on. They are then placed in the larger jar, entirely immersed in the alcohol, and are boiled for an hour. On cooling they are taken from the larger vessel, and their caps are tightened and only removed when the gut is to be used.

Dry sterilization of catgut has been variously recommended. Reverdin, who was the first to adopt this method, heated the gut for five hours to 150° C. Although it had lost some of its firmness by this process, it was still of good quality. From culture experiments he concludes that sterilization for four hours at 140° C. is sufficient. Benckiser, on the other hand, asserts that absolute disinfection of the gut is obtained by a heat of 130–140° C. in from one and one-half to two hours. The material becomes somewhat brittle, but, if it is placed in fluid before being used, it again assumes its normal consistency. One of the latest advocates of dry sterilization of gut is Braatz. After a long series of experiments he recommends heating to 150° C. for forty-five minutes, for which purpose he has constructed a self-regulating apparatus, in which the gut is placed in a separate metal box. The box will close hermetically, excluding, as the inventor asserts, "dust and other impurities." After sterilization the box is opened, what is needed of the gut is taken from it, it is again closed, and, can be thus kept for further operations, but how long the author does not state. One of the most important points in sterilization by heat is that it should, if possible, take place immediately before the articles thus prepared are used. When once exposed, however, they ought to be sterilized again, and it cannot be claimed, therefore that Braatz's box is a distinct advance toward ideal asepsis. The gut it contains may remain sterile for a long time, and, as its interior has been once thoroughly heated and sterilized, we need not very much fear infection from atmospheric germs. If it does not occur, there is, nevertheless, a chance of infection by direct contact. It is rather against the principle that I contend, the introduction of an uncertain factor into the aseptic system. The method of sterilization by boiling in alcohol seems preferable, therefore, when sterilizing by heat. On the other hand, I am convinced that the method of sterilization in watery sublimate solutions also furnishes a reliable material, and the simplicity of the method certainly is a strong factor in its favor.

Fig. 1563.



Braatz's Box for Sterilizing Catgut.

Silk is sterilized by boiling water or by steam. Neither method injures the material, even when frequently applied. It is safest to sterilize the silk before each operation, as preservation in 1–1000 sublimate solution soon makes the finer qualities unfit for use, and even

affects the heavier threads. Halstead winds silk on glass spools, using about two metres for each. The latter are of such size that eight of them will fill an ordinary glass test-tube, and this plugged with cotton is placed in a steam sterilizer. When sterilization is finished, the spools are poured from the test-tube into a dish containing a solution of carbolic acid, 1–30. Some surgeons prefer to use the silk in a dry state, after it has been sterilized by steam, claiming that antiseptics will irritate the tissues. Silk that has been sterilized by boiling must be preserved in some antiseptic fluid, or must otherwise be again boiled before being used. Therein lies an advantage of sterilization by steam, as silk once sterile can be preserved in that state for an indefinite period by the method of Halstead, just described.

DRESSINGS.—In no other particular has the aseptic principle exercised so beneficial an influence as in the matter of dressings. If materials impregnated with antiseptics have not yet been entirely discarded by all surgeons, it appears that this will soon occur. It is true that we strive to-day to accomplish just what Lister had in mind when he described his carbolized gauze dressing, to exclude by means of our aseptic appliances the causes of wound-infection, but we take greater precautions now to obtain this result during other surgical manipulations before the dressings are applied, and not by saturating the latter with antiseptic fluids and by sealing wounds hermetically with impermeable rubber tissues, as was the custom in the beginning of the antiseptic era. On the contrary, we have learned to regard evaporation of the discharges in the dressings as a very important factor in wound treatment. Many, indeed, have been the materials and the antiseptic substances which have been recommended to the profession at various times since Lister's first publications, for the preparation of antiseptic dressings. To-day we consider the following sufficient for all the needs of the surgeon:

I. Dry sterilized gauze (cheese-cloth, tarlatan).

II. Iodoform gauze.

III. Moist antiseptic dressings.

Lister was one of the first to call attention to the merits of *gauze* as a material for dressings, and, although various attempts have been made to supplant it by other cheaper materials, it seems to possess these merits to such a degree that surgeons in general have never looked on any of the others with favor. It is true that its absorbent qualities are not as great as those of the different varieties of cotton and of wood-wool, but they are apparently greater than those of other materials, such as turf-moss, jute, and sawdust, which are also in demand as substitutes. The quality of being able to readily absorb wound-secretions has been recognized as a most important one in a good material for surgical dressings, and gauze possesses this quality in a marked degree. It, furthermore, allows evaporation of the discharges which it has absorbed, more readily than most other materials. In one essential point, however, it surpasses all the others: it is especially well adapted to the tamponing of wounds, a form of dressing extensively used at the present day.

It can scarcely be of more than passing interest to mention the methods in use during the past ten or fifteen years for the preparation

of antiseptic dressings, with the one exception of iodoform gauze, which is still very justly much esteemed. The sublimate dressings so largely employed but a few years ago have now been generally abandoned in favor of plain sterilized gauze, since it has been established that the small amount of the antiseptic in dry sublimate dressings quickly combines with the albuminous substances in wound discharges, forming compounds of very doubtful germicidal power. The value of the sublimate in the gauze as an antiseptic is, therefore, very questionable, unless it is introduced in so large a quantity that it will also cause irritation of the wound-surfaces and possibly intoxication by absorption. To obviate these disadvantages Lister has lately recommended an antiseptic gauze impregnated with the double cyanide of zinc and mercury. This salt is insoluble in wound-secretions, and is, therefore, not decomposed by the latter. It is neither irritating nor poisonous, but its preparation is unfortunately a very tedious process. We do not, however, to-day look very much to the antiseptic properties of our dressings; we desire them in the first instance to be aseptic. This is not readily accomplished by impregnation with antiseptics. It has been shown that commercial antiseptic gauze frequently contains micro-organisms, even in the centre of the packages in which it appears in the market, and this is readily understood when we recall the various manipulations during impregnation, drying, and packing. The moist commercial article is, therefore, from this point of view preferable. The best manner of preparing sublimate gauze is the following: Boil the gauze in a solution of washing-soda, in order to remove fatty substances, then soak it in a watery solution of sublimate, 1–500 or 1–1000, to which two parts of chloride of sodium have been added for every part of the mercurial. Then dry and preserve in sterilized vessels.

The simplest and at the same time the only certain way of obtaining absolutely sterile dressings, is through disinfection by heat. Dry heat is, we know, much inferior to boiling water or steam as a sterilizing agent, and, as boiling necessitates drying afterwards, steam sterilization has now been universally adopted. It is not much more than ten years since dry heat was exclusively used in the large sterilizing chambers of European hospitals for the disinfection of bedding, clothes, etc., but about that time the superiority of steam in this respect was made apparent by the researches of Koch, and it very soon supplanted dry heat. Bulky articles, exposed for hours to dry heat of more than 100° C., were not at all disinfected in their interior; in fact, it was amply proven by experiments that the temperature in the middle of such bundles of clothing or other articles never, during their long exposure, reached a point anywhere near that of the air in the apparatus. This is quite otherwise with steam, which when saturated penetrates very quickly. The application of dry heat has another serious drawback, the fact that the high temperature necessary for sterilization frequently damages the articles in the chamber. Steam has none of these disadvantages.

A great deal of experimental work has been undertaken in late years to determine the conditions under which the sterilizing power of steam is greatest. The following may be taken as the conclusions arrived at:

I. Simple, circulating steam at 100° C. possesses very great disinfecting power. It kills the spores of anthrax in five minutes, whereas

it takes from three to four hours to destroy them by dry heat of 140° C.

II. Circulating steam loses much of its disinfecting power when superheated without pressure. When its temperature is 140° C. it is not much more potent than dry air at the same temperature.

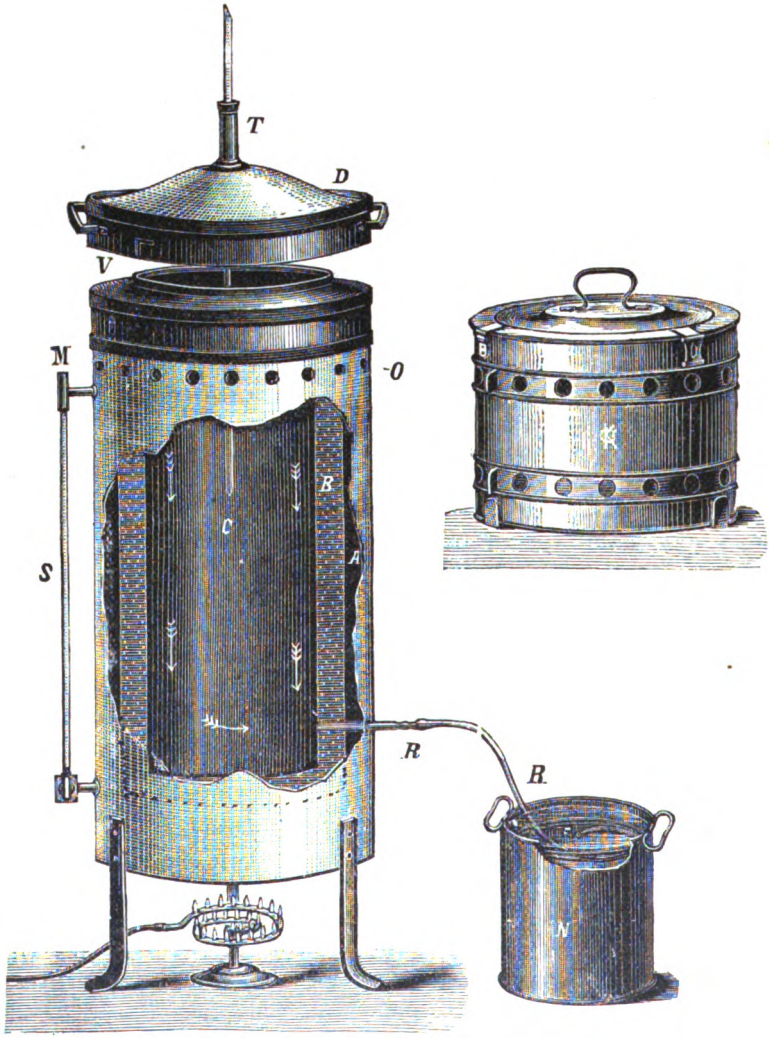
III. The strongest disinfecting agent is superheated steam under pressure. When used in this way, all air should be expelled from the disinfecting chamber before the steam is put under pressure, as otherwise its sterilizing power will be much reduced. To insure the most rapid and powerful action of steam, the thermometer and steam pressure gauge should always correspond in their indications—for example, at 240° F., the pressure ought to be about ten pounds to the square inch; then the steam in the disinfecting chamber will be saturated, and consequently most powerful.

In the construction of sterilizing apparatuses for surgical dressings, all these conclusions have been turned to advantage. In large hospitals, where a great amount of sterilized material for dressings is required, the somewhat expensive permanent apparatuses employed in some of the hospitals in New York, notably the Roosevelt and Presbyterian, answer an excellent purpose. They work with superheated steam under pressure, and supply absolutely sterile materials. But where simplicity of procedure is imperative, sterilization by circulating steam will be found entirely sufficient. It certainly will put the dressings into fully as aseptic a condition as the means now employed in the sterilization of other things that come in contact with wounds (hands, catgut, etc.), and it will certainly destroy all those germs which are responsible for wound-infection in general.

The apparatuses which have been devised for sterilization with circulating steam are numerous. It cannot lie within the scope of this article to mention the variations in size and shape to which the inventive genius of some surgeons has subjected the original steam-pot of Robert Koch. An apparatus which answers quite well is the familiar Arnold steam sterilizer. Schimmelbusch was, I believe, the first to embody in a practical way the principles of sterilization by circulating steam in the construction of his well-known sterilizer for dressings. It consists in the main of two copper cylinders of unequal size (Fig. 1564), the space *B* between the two being utilized as a reservoir for water. The latter is filled at *M*, and the glass tube *S* indicates the quantity of water in the reservoir. It is sufficient to fill it to about half its capacity. The gauze to be sterilized is placed in metal boxes, shown in Fig. 1564, a certain number of which fit into the sterilizer. They are provided, at their upper and lower parts, with apertures in the shape of a band which can be opened and closed. These are opened before the box is placed in the sterilizer, to allow the steam to enter. Then the apparatus is firmly closed and heated. The water becoming warm, also warms the gauze before the latter is steamed, which almost entirely prevents condensation of aqueous vapor on its surface. When the water boils, steam passes through small openings at the top of the inner cylinder (not shown in the illustration) into the disinfecting chamber *C*, and then in the direction of the arrows through the previously heated gauze, leaving the apparatus by the tube *R*. This in turn ends in a condenser *N*, filled with cold water, thus preventing the

escape of steam from the apparatus, which would be an inconvenience. After the water has boiled for fifteen minutes it can be safely assumed that the steam has reached every part of the gauze, and then steaming should be continued for another half-hour. The boxes containing the dressings are removed while still warm, and, if kept open for a few moments, the aqueous vapor will escape, and the material will be quite

Fig. 1564.



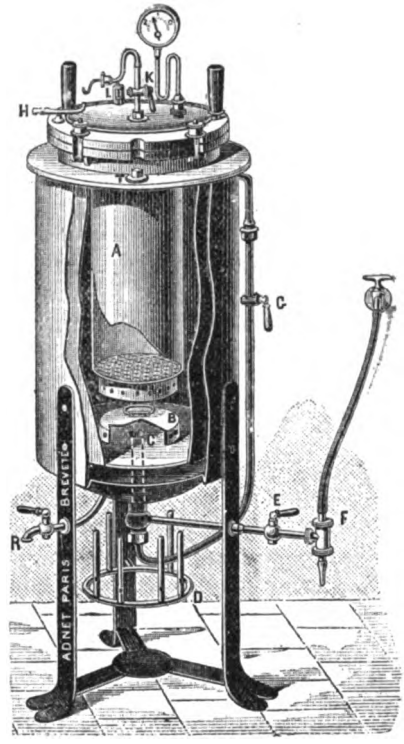
Schimmelbusch's Sterilizing Apparatus for Dressings, Gowns, Towels, etc.

dry. Then the covers and apertures are closed, and the sterilized material is ready for transportation or for immediate use as the case may be.

In France more especially, sterilization by superheated steam under pressure has been much employed, and sterilizers, resembling in size and shape, and somewhat in construction, that just described, have been constructed. One of the latest is the sterilizer of Sorel, of

Paris. (Fig. 1565.) Here also the steam is generated between two cylinders, and passes through the tube *G* and the opening *C* into the inner chamber *A*, which contains the dressings. The apparatus is put under a pressure of thirty pounds. There is a safety-valve at *L*. The stop-cock *K* answers the double purpose of allowing the steam under pressure to escape from the inner chamber after sterilization is complete, and, afterwards, when the air in *A* has been exhausted by the current of water passing through *F*, of allowing the introduction of sterilized air. This is effected by heating the platinum point of *K* by the gas-jet *H*. This brief description will suffice to indicate the working of the apparatus. It has the advantage of rapid sterilization. Under pressure of thirty pounds to the square inch, five minutes is said to be sufficient. It is possible that sterilization by this apparatus is more certain than by those without pressure. But the latter will rarely fail to destroy all organic life, and are much less complicated. Similar apparatuses, more simple in construction and equally efficient, have lately been made in this country.

Fig. 1565.



Sorel's Sterilizer for Dressings.

Iodoform gauze may best be prepared in the following way: Boil the gauze with washing-soda and, after drying, determine by weight the amount of iodoform to be distributed in a certain quantity of gauze. Saturate the gauze with ether, and wring it out, and in the ether thus obtained dissolve the iodoform. Then place the gauze in the iodoform-ether, and, after it is uniformly saturated, raise it and spread it so that evaporation of the ether may rapidly occur, when the iodoform will be evenly distributed throughout the gauze. Weir's method is to mix three drachms of powdered iodoform with six fluid ounces of suds, made with castile soap and a 1–5000 sublimate solution. Pour this emulsion over and into two and one-half yards of gauze, which will make a 10-per-cent. iodoform gauze. A simple and good way is to rub finely powdered iodoform into sterilized gauze immediately before using it. We do not get a definite percentage of iodoform in the gauze by this means, but this does not seem to be important.

For *moist antiseptic dressings*, which are occasionally indicated, a 1–5000 sublimate solution or, preferably, Thiersch's solution (salicylic acid, 2 parts; boric acid, 12 parts; water, 1000 parts) should be employed. Acetate of aluminum in a one-per-cent. or two-per-cent. solution also answers very well in this case.

DRAINAGE.—The best material for drainage-tubes still is vulcanized

rubber. Glass and decalcified, absorbable bone tubes, which have been used as substitutes for India-rubber, are not as well adapted for the purposes of drainage as the latter. A drainage-tube should be elastic and flexible, so that it may not exert pressure upon the soft parts through which it passes. The absorbability of bone tubes is, moreover, a very uncertain factor, as pointed out by Neuber himself, the tube sometimes being absorbed too soon, but more frequently lying in wounds an unnecessary length of time. Strips of gauze cannot always afford proper drainage for deep wounds. To render India-rubber tubes aseptic, they should be boiled in water for several minutes, and then be placed in a 5-per-cent. solution of carbolic acid, not in sublimate solutions. They can be sterilized a few times in boiling water without injury.

BANDAGES, APRONS, AND TOWELS used during operations should be sterilized by steam in the manner already described for dressings, in preference to moistening them with antiseptic lotions. Care should be especially taken not to apply wet towels immediately to the body of the patient, as in a serious and lengthy operation the loss of heat which this would entail might very perceptibly increase the shock.

DRESSING WOUNDS.—I have now described the materials which the surgeon who practises modern aseptic wound-treatment employs. It seems customary of late with writers on this subject to emphasize the simplicity which obtains in the *technique* of modern wound-treatment, when compared with the original Listerian system. What this assertion is in reality based upon, is not apparent. The disinfection of hands and field of operation has become a much more complicated procedure; our instruments must be boiled, whereas formerly they were only placed in a carbolic solution; and the preparation of sterilized dressings, bandages, gowns, etc., and of iodoform gauze, as practised to-day, cannot well be termed a simplification in *technique*. The statement is better made of another part of wound-treatment, namely, the frequency with which wounds are dressed. That *infrequent dressing of wounds* was desirable under all conditions, was soon recognized in the new antiseptic era, and it has been the endeavor of surgeons to develop this idea in many ways. Even to-day some difference of opinion still prevails as to how this may best be accomplished, more especially in regard to the entire or only partial abolition of drainage in aseptic surgery. Neuber was the first to emphasize the importance of permanent dressings (Dauerverbände) and to elaborate, after many years of trial, a system of wound-treatment based upon this principle. That every dressing causes more or less irritation in wounds, and, at least theoretically, exposes the wound to the risk of infection, cannot be denied. That great differences, however, exist in the amount of irritation, according to the location and nature of the wound, must also be granted. Thus, for example, a change of dressings soon after operation at the knee-joint, where it is difficult to avoid motion even with the greatest care, will more likely be followed by local or general disturbance than such a change after extirpation of a lipoma, say of the back. But, even allowing some individualization in this regard, the principle that strict indications for each change of dressing should exist, is now universally acknowledged.

If we can bring wound-surfaces into close approximation, if there has been no undue irritation of the same, and if no infection has occurred during the operation, the chances are that the amount of discharge will be very moderate, if any, and that primary union will follow without drainage. Are we able to guarantee this result, with the modern aseptic treatment of wounds, with such certainty, and are the risks we incur in closing all aseptic wounds so slight, that even careful dressing some days after operation, to remove drainage-tubes, must be considered a decided disadvantage?

We have seen by what precautions in the preparation for an aseptic operation we may almost to a degree of absolute certainty avoid infection. On the other hand, we know how difficult it is to secure thorough disinfection by any other means than by heat, and how true this is, especially of the hands and nails of the operator. Even the most painstaking surgeon will occasionally fall short of ideal asepsis in this regard, and, if infection does not always follow such failure, we must attribute this to the vitality of the body-cells and to other mechanical conditions in wounds, which make them an unfit medium for the development of the germs that have been introduced in small numbers. Still, we believe that even those who have most carefully carried out the treatment without drainage, have occasionally observed wound-infection in a distinct manner.

Such accidents may be most surely prevented by thorough asepsis in the first place; in the second place, by avoiding irritation of the wound-surfaces. This is accomplished by clean surgical work, and by abstaining from irrigation with antiseptic fluids. The latter is entirely unnecessary when asepsis has been efficiently carried out during an operation, and it is safe to say that the surgeon who achieves better results by the use of antiseptic irrigation than without the latter, is not a master in this form of wound-treatment. When irrigation of aseptic wounds becomes necessary to wash out blood-clots or bone chips, for example, this is best done with a physiological salt solution (7–1000), which ought to be boiled before use. It is more for their irritating than their poisonous qualities that antiseptics are unsuitable for irrigating purposes. Whenever strong carbolic or sublimate solutions are brought in contact with wound-surfaces, necrosis of the superficial cell-layers follows, and, although this may not become immediately apparent, it cannot but interfere with primary union. The dangers of intoxication with carbolic acid and corrosive sublimate are not as great as they have been said to be by some writers. It is astonishing, at least, that, if real, they should never have been observed by many who in former years used these antiseptics extensively for irrigating purposes.

Some surgeons prefer not to irrigate at all, and their results are as good, apparently, as those obtained by others. When once properly disinfected, not a drop of fluid is brought in contact with the field of operation after the first incision has been made. While the surgeon is engaged at one part of the wound, the remainder is covered with gauze, and thus hemorrhage is controlled without ligatures at the time, but eventually, before suturing, the larger vessels are tied. The wound-cavity is then once more firmly packed with gauze for several moments. When this is finally removed the wound will be perfectly dry, and very large surfaces can then be united, using if necessary buried sutures,

without establishing drainage. It does not seem, however, that the question of moderate irrigation with aseptic fluids, or of no irrigation at all, is one of primary importance. Some individuality seems appropriate here. In wounds of great depth, where the parts can only be exposed with much effort, and by the use of instruments, a piece of gauze may prove a positive annoyance to the surgeon during his work. In more superficial wounds the plan is a good one. It does not seem, however, that occasional irrigation with a sterilized salt solution should endanger the good results of the dry method of operating (Landerer). Care should only be taken to fulfil the other requisites of the method, to arrest hemorrhage, and to have the wound perfectly dry before suturing.

In ordinary cases the *arrest of hemorrhage* is a most important factor in wound-treatment. Whether this is best accomplished by compression, as already described, or by ligature or torsion of the vessels, is an open question. Both methods will probably always remain in favor. A ligature is a foreign body, which is either absorbed or remains encapsulated in the tissues. But if suppuration supervenes, as is now and then the case when the abdominal cavity has been tamponed, the silk ligature may become the cause of long persisting sinuses, which only close when the threads have come away—sometimes after years—a decided disadvantage. Ligatures should, therefore, be applied only to those vessels which cannot be controlled by torsion or compression. Catgut should be employed for this purpose with few exceptions, even though so distinguished an authority as Kocher has declined to further use it, believing that sterilization of the raw material is not always possible. Others have even asserted that the gut is an excellent medium for the development of germs that have accidentally entered wounds. But these arguments cannot weigh heavily when the property which pre-eminently qualifies catgut for the ligature of vessels, its absorbability, is considered. Moreover, we now know that catgut can be rendered absolutely sterile.

In blood-clots which lie in wounds, germs find a very favorable soil for further development. When this occurs the clot is liquefied and disorganized, and escapes from the wound with the secretions. On the other hand, when perfect asepsis prevails, coagulated blood may lie in a wound for many days without apparently undergoing any change in size or shape. Gradually it begins to shrink, and to lose its dark color, and finally it disappears in the granulations which encroach upon it from all sides. This process of organization of blood-clot was first described by Lister, and also by Volkmann in the early days of antiseptic surgery. The latter fully recognized its value, in cases in which large surfaces of bone, which would otherwise have lain exposed, were covered by a clot undergoing organization. Necrosis and exfoliation were thus often prevented. But it was Schede who first recommended healing under the moist blood-clot as a novel form of wound-treatment, claiming for it a large field of usefulness. His teachings were directly opposed to the opinions generally held by surgeons, who advocated, and still do advocate, the removal of all blood before closure of a wound.

Schede's attention was first called to his new method of wound-treatment by the good results obtained in the operation for club-foot as practised by Phelps. There a large clot lies between the separated wound-

surfaces, and, if covered by a piece of protective silk, organizes in a few weeks, providing no infection has occurred. Schede applied the principle herein involved to resections of all the joints with the exception of the hip, but more especially to the treatment of bone cavities, the result of operations for necrosis or tuberculosis, and of compound fractures, where a loss of substance has resulted from comminution. He also employed the method where large defects in the soft parts after extirpation of tumors and other operations did not permit an exact approximation of the wound-surfaces. To apply the method properly, the cavity in the bone or the soft parts should be rendered entirely aseptic. If the integuments can be brought together by sutures, shutting off the cavity, this is done, leaving for the discharge of superfluous blood, generally at the uppermost part of the wound, one or two openings which are covered with bits of protective silk. If sutures have not been used, the opening to the cavity is also covered with protective, overlapping the edges to prevent evaporation of the blood in the cavity, and also to guard against absorption of the blood by the aseptic dressing, which is next applied. It is important that there should be enough blood to fill the cavity, but this should not be under any tension. If success attends this plan of treatment, the first dressing may remain for from two to six weeks, when on removal complete union will be found, or the clot will have been transformed into cicatricial tissue. The method is not, however, always successful. In rare cases, even if no infection has occurred, the blood does not coagulate, and does not, therefore, fulfil its purpose. In operations for necrosis of bone, also, where thorough asepsis cannot always mark the course of the surgeon's work, owing to the infiltration of the surrounding bone with microorganisms, failures are frequent. Then disorganization follows, and the bone-cavity must eventually be treated according to the old plan of tamponing and healing by granulation, and no further harm will result. In the treatment of tubercular bone affections, on the other hand, great care should be taken to remove all diseased tissue before healing beneath the moist blood-clot is attempted. Otherwise primary union may be followed by a recurrence of the old trouble, and a breaking-down of the already organized clot. It is an especially difficult task to remove with certainty all tubercular material from a diseased hip, and resections of this joint have, therefore, never been considered suitable cases for healing beneath the moist clot. In operations where tendons have been exposed, and perhaps deprived of their sheaths, as is frequently the case on the dorsum of the hand, the method answers an excellent purpose; but it must not be assumed that divided nerves and tendons will re-unite without suturing more readily by this than by any other method of wound-treatment.

I have frequently alluded to that form of wound-treatment, which, like the method of healing beneath the moist clot, aims at a reduction in the number of dressings and at total abolition of drainage, of which Neuber has been the main exponent. The means employed to attain these ends are exactly the reverse of those used in the method of Schede, just described. All hemorrhage is carefully arrested, and the formation of cavities within the sutured wound is scrupulously avoided, in the belief that close coaptation of wound-surfaces is the best guarantee for rapid and undisturbed healing. According to the location of

wounds this is accomplished in various ways. In the soft parts, simple compression will frequently suffice to bring the sutured surfaces into approximation with the underlying parts, or this may be done with the assistance of a few sutures (Fig. 1567, $\alpha\ \beta$) placed subcutaneously. (Figs. 1566, 1567.)

If the wound-cavity is deep, buried sutures can be employed with advantage, as illustrated by Figs. 1568, 1569, 1570, 1571.

In dealing with bone-cavities, the adjacent soft parts can be utilized

Fig. 1566.

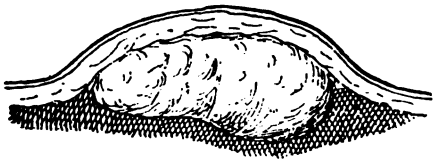


Fig. 1567.

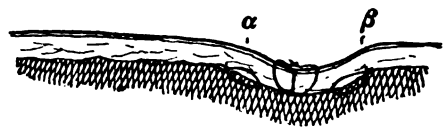


Fig. 1568.

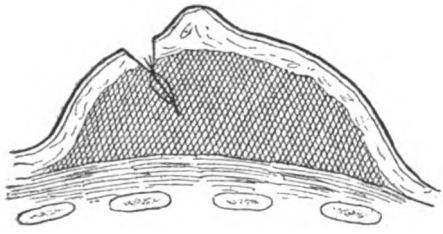


Fig. 1569.

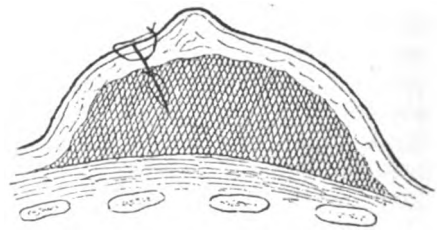


Fig. 1570.

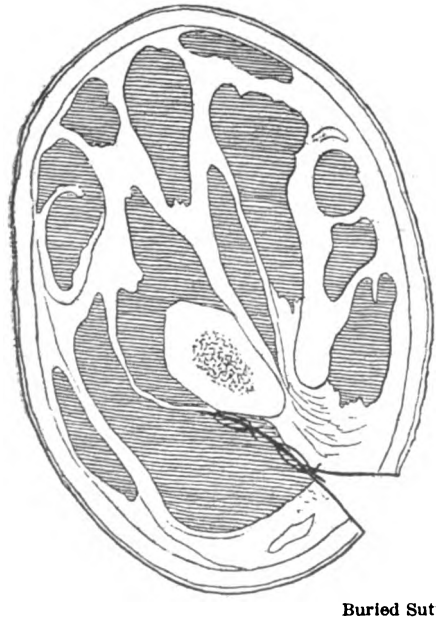
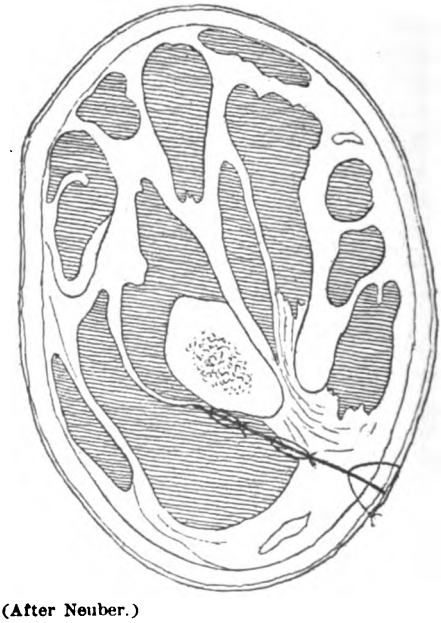


Fig. 1571.

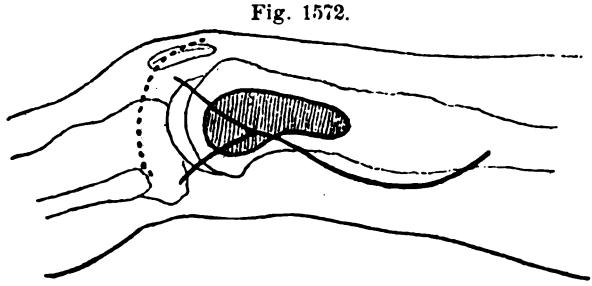


Buried Sutures. (After Neuber.)

in the formation of suitable flaps, which are implanted upon the denuded bone surfaces and held in place by nails and accessory sutures

(Fig. 1572). This plan is also practicable in cases where the soft parts are too rigid to admit of approximation by buried sutures. After resections, the bone surfaces are brought into direct contact to prevent the formation of dead spaces, a precaution which is not at all necessary when such cases are treated with the moist blood-clot.

Fig. 1572.



After Neuber.

During the first period of the development of this method, drainage was considered indispensable. Neuber at that time recommended the use of absorbable drainage-tubes, hoping thus to avoid a change of dressings for their removal. He soon abandoned them, however, for reasons already mentioned, and adopted a method of drainage which he termed "canalization of wounds." This consisted in the punching of holes through the skin and subjacent tissues at certain intervals, through which holes ample drainage was afforded. But this plan was also soon given up in favor of loose sutures, which permitted the intervening wound-edges to separate slightly, allowing the secretions, if there were any, to escape. Furthermore, the original incisions were so placed that their ends, or one of them, corresponded to the lowest part of the wound, which was eventually left unsutured. (Fig. 1573.) Sometimes a small Λ-shaped flap was cut at the ends of the incision, and at the close of the operation its tip was sutured to the deepest part of the wound, thus establishing a groove

Fig. 1573.

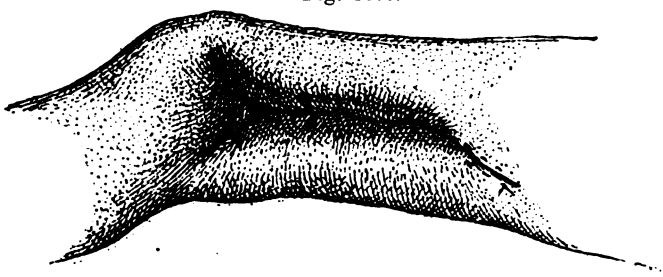


Fig. 1574.

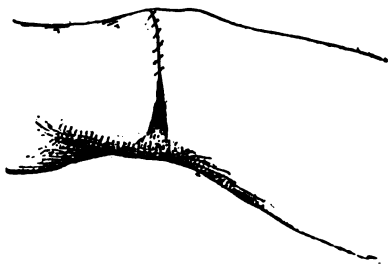
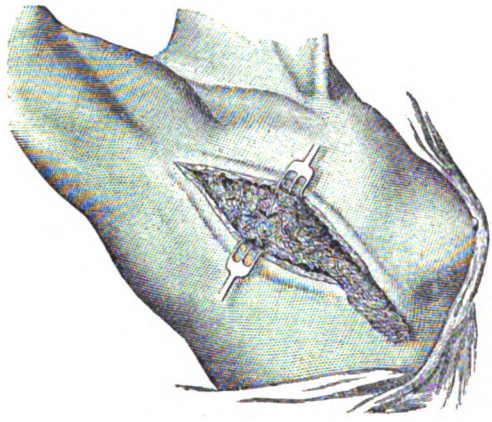


Fig. 1575.

along which the secretions could run into the dressings (Figs. 1574, 1575)—a plan especially well adapted to resections of the knee. In his latest publication Neuber discards drainage altogether, and, relying on

his method of wound-treatment, closes all aseptic wounds hermetically. To facilitate this a piece of sterilized gauze is packed into the wound at the end of the operation and allowed to protrude from the lower angle (Fig. 1576). The wound is then sutured, with the exception of that part from which the gauze escapes, and here a few untied sutures are placed (Fig. 1577). Firm compression is now exerted upon the line of suture, and continued until all the blood and secretions have been expelled from the wound by way of the tampon. The latter is then extracted, the last sutures are tied, and the wound is entirely closed (Fig. 1578), compression being all the time exerted to prevent the entrance of air into the wound. An aseptic dressing is finally applied.

Fig. 1576.

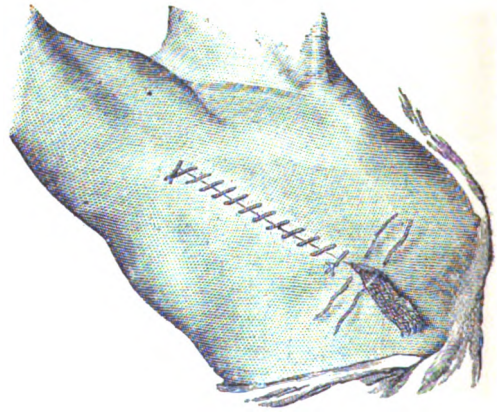


After Neuber.

Most surgeons to-day, we venture to assume, combine the methods of Neuber and Schede in the treatment of aseptic cases. They still believe in removing all blood-clots from wound-surfaces where coaptation is possible, but they allow such spaces as cannot be obliterated by suture or compression to fill with blood, and trust to organization.

When dealing with wounds of any depth, even though perfectly aseptic, many surgeons still employ drainage-tubes, believing that the inconveniences which their use entails are fully offset by the assurance that no retention can occur, and that the risks of infection are in consequence minimal. When drainage-tubes are used, they should be entirely removed at the end of about a week, if everything has gone on satisfactorily. They should not be shortened, or removed and reintroduced. Their purpose has been to supply a safety-valve during the first days of reaction and secretion, and they can now be dispensed with, having fulfilled their object, since they further act only as foreign bodies in the wound. Their track will then close rapidly. To avoid a complete removal of the dressings, it has been suggested to so arrange the tubes at the outset that they can be removed without uncovering the wound. This plan is somewhat cumbersome, and has never met with general favor. It possesses no advantage over com-

Fig. 1577.

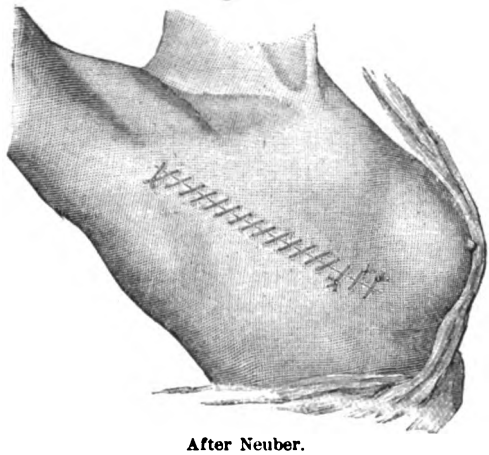


After Neuber.

plete exposure of the wound under proper precautions. The dangers of infection and irritation by a renewal of the dressings have been much exaggerated. The inconvenience to the patient is almost of greater significance; and here there is another view to be taken of the matter. The patient will in all probability be more comfortable if the secretions are carried by drainage-tubes into the dressings, than if they remain shut up in the wound, even in an aseptic condition, awaiting absorption. From all that has been said, we conclude that a precise statement regarding the position of drainage in aseptic surgery is to-day impossible. It must remain with every surgeon to decide to what extent he can attain the ideal of no drainage and of healing under one dressing, with or without the moist blood-clot. His mastery of asepsis and the conditions under which he works will influence him largely in his decision.

There may exist, however, other indications for a change of dressings which are unequivocal. If the temperature of the patient, after the usual reaction of the first few days, when the thermometer is likely to register a few degrees above the normal, does not drop, and if his general condition indicates that absorption from the wound is going on, the dressings ought to be removed, and the necessary steps taken to insure free exit of the secretions, or of the blood clot, which the surgeon has not succeeded in keeping aseptic. It is a good plan, further, to apply in these cases a moist antiseptic dressing with Thiersch's solution, or a solution of acetate of aluminum, as already described, whether the wound has been opened or not. In the latter event it may be possible to master the inflammatory symptoms without entirely sacrificing primary union. It seems a better plan, in applying a moist dressing, to cover it with some impermeable material, such as rubber tissue or protective, than to rely on frequent irrigation for keeping it moist. If we are dealing with open wounds, a frequent change of dressings, once a day at least, is advisable, to guard against a too rapid development of micro-organisms, which shutting off the dressing with protective undoubtedly favors. It has been proposed to moisten only the deeper layers and to place over them a dry aseptic dressing. The full benefit of a warm and moist dressing is, however, better obtained in such cases by making it impermeable than otherwise. When the reaction has passed off, a dry dressing may be again employed. When soon after an operation a bloody or serous discharge appears on the external surface, it will suffice to protect the spot with a piece of sterilized or iodoform gauze, and to allow evaporation of the secretions to take place. If the discharge is more abundant, it will be proper to remove the superficial layers, and to replace them by fresh pieces of gauze

Fig. 1578



After Neuber.

or other aseptic material. It has been suggested to cover that part of the dressing which corresponds to the wound, in cases in which we anticipate much oozing, with rubber tissue, which prevents the discharges from showing on the surface and from opening a path of infection from the outer world to the wound. But this should certainly not reach to any extent over the external surface of a dry dressing, otherwise evaporation of the secretions may be interfered with. The latter is justly considered one of the most important factors of modern aseptic wound-treatment. Nothing will more surely prevent the development of micro-organisms in dressings than rapid evaporation of the discharges that have escaped into them. It is not necessary for this that the discharge should have appeared on the external surface of the dressing; on the contrary, gauze and moss, for example, which absorb rapidly, will also allow evaporation through much of their material which is still dry. On the whole, it seems a better plan to avoid entirely the use of impermeable materials in the application of a dry aseptic dressing, more especially as we are able to control oozing by the proper manipulations in almost all cases, and because we can detect and remedy a weak spot in an aseptic dressing immediately.

A method of wound-treatment which may be occasionally employed with much advantage, is the *tamponade of wounds*. This may be either temporary or permanent. When used only temporarily, it is employed mainly to control capillary oozing from wound-surfaces, which cannot be checked by other means, and to lessen the risk of infection in cases in which the surgeon, apart from the nature of the ailment, does not for some reason or other feel sure of an aseptic course from the outset. Kocher some years ago extended this plan to the treatment of almost all wounds. His method was to tampon at the time of operation, and to introduce the necessary sutures for closing the wounds, leaving them, however, untied. At the expiration of two or three days, having assured himself of the aseptic condition of affairs, the tampons were removed, and the wounds, which had been treated with subnitrate of bismuth as an antiseptic, were closed by tying the sutures already in place. A second use of anæsthetics was thus avoided. Following Kocher, von Bergmann has used this method very extensively in the treatment of some aseptic wounds. A great advance in his method was the substitution of iodoform for subnitrate of bismuth. He furthermore abandoned the introduction of sutures at the time of the operation, preferring, two or three days later, to again anæsthetize the patient for removal of the tampon and closure of the wound. The advantages claimed for this plan are the easy control of hemorrhage, which may occur during extraction of the iodoform gauze, and the greater comfort to the patient and the surgeon during the necessarily somewhat extended secondary manipulations. Von Bergmann employed the method more especially in resections of joints, but also in compound fractures involving the joints and the skull. When, for example, after resection of the knee, the tampon is removed on the second day, the wound-surfaces will have a perfectly fresh appearance, and will be equally well adapted to suturing as at the time of the operation. It is not improbable, however, that temporary tamponade in aseptic cases will soon be entirely abandoned, except in those in which excessive hemorrhage is going on. In operations on the brain, and

even elsewhere, when severe venous hemorrhage occurs, it is sometimes impossible to control this otherwise than by tamponing the wound for a period varying from several days to a week or more. But for general application to resection of joints, the method seems to possess no advantages over that which advocates arrest of hemorrhage, close coaptation of the bone surfaces, and healing beneath the blood-clot, where open spaces are unavoidable. If we close such a wound at the end of the second day, we are no more able to guarantee against recurrence of tuberculous disease than by the plan just mentioned. In both instances we avoid filling the cavity of the exsected joint with blood, which during and after organization is so excellent a medium for the rapid growth and dissemination of the tubercle bacillus, in case we have failed to remove all diseased tissue. The surest way of guarding against recurrence after operations for extended tuberculosis, is to tampon permanently after resection, a method applicable to many joints. We can then detect a recurrence, and can deal with it before it assumes large proportions.

But it is mainly after operations involving the mouth and nose, their adjacent cavities, and the rectum and vagina, that the permanent use of iodoform-gauze tampons is of inestimable value. There is perfect accord of opinion among surgeons as to the efficacy of this plan of treatment. The discharges, which otherwise become foul, causing by their absorption intoxication and occasionally sepsis, remain sweet, even if the tampons are not removed for many days. The dangers of septic peritonitis after operations on the rectum and the uterus, and of septic pneumonia after resection of the jaws, have been much lessened since the iodoform-gauze tampon has been recognized as the proper dressing for these cases.

Iodoform is, therefore, the one antiseptic which we occasionally apply to wounds with signal advantage. Its use is indicated in originally aseptic wounds, which from their situation will be subsequently exposed to the risk of infection. Where this is not the case, iodoform ought not to be employed. It is not logical to prepare and perform an operation aseptically, and then, before applying an aseptic dressing, to dust the line of suture with iodoform, or to cover it with a piece of iodoform gauze, as is still frequently done. This could only be deemed consistent with an aseptic *régime* if sterilization of the powdered iodoform and the preparation of iodoform gauze, with solutions of iodoform, always immediately preceded their use. Iodoform, it is said, can be sterilized by washing it in sublimate solutions. But that this is seldom done by those who apply the powder to wounds is quite certain. Others consider the powder sterile when it leaves the manufacturer's hands, which is hardly a guarantee, however, that it is so when used. Iodoform gauze prepared from solutions in ether, or ether and alcohol, is, as has been shown, sterile, and there could be no objection to its use, if it were always thus prepared before operation. But this is, I feel assured, but rarely the case. It is a procedure which would, moreover, unnecessarily complicate asepsis. In aseptic surgery the aim must be to dispense with antiseptics about wounds and in the dressings.

Does iodoform possess any antiseptic properties? When first introduced as a dressing for wounds by Mosetig-Moorhof, almost fifteen years ago, it soon gained favor with the profession, and was regarded, on

the basis of extended clinical experience, as a powerful antiseptic. It caused, therefore, quite a commotion among surgeons, when Hejn and Roosing in a well-known publication disclaimed for it all power in this direction. Surgeons were, however, unwilling to accept the results of culture-tube experimentation, even though verified by other investigators, as identical with the action of the drug when in contact with the human body. If iodoform has none or very little influence on germs in culture-media, it evidently does influence their growth in the living body. Various theories have been offered in explanation of this fact. Some believe that iodoform increases the vital action of the tissue cells in their conflict with germs; others that iodine, set free by decomposition of a certain quantity of iodoform, exerts an antiseptic influence. According to Koenig iodoform decreases to a great extent the secretion in wounds, and thus removes the medium in which germs develop. Of late, the chemical action of iodoform upon the ptomaines, the products of germ-life, seems to offer the best explanation of its action on wound-surfaces. We know from the work of several investigators that ptomaines can cause suppuration without the presence of the germs which have produced them. On the other hand, the germs without the ptomaines do not always excite suppuration. But the most important outcome of the vast amount of experimental labor devoted to this subject is, that ptomaines, when mixed with iodoform, do not cause suppuration. The former seem to possess the power of decomposing the latter, but they are themselves rendered inert by this chemical change. We may assume, therefore, that the antiseptic qualities of iodoform are due to its affinity for the irritating products of the growth of bacteria, but that it is not a parasiticide, exerting a directly destructive influence upon micro-organisms, as is carbolic acid or corrosive sublimate.

The treatment of infected wounds should be conducted on the same principles as that of clean wounds. There is no reason why we should any longer to-day uphold the doctrine that clean wounds are to be treated aseptically, and infected wounds antiseptically, that is, with the liberal use of antiseptics for irrigating purposes and for the impregnation of dressings. The one great object in dealing with infected wounds should be the provision for free discharge of the secretions which are contained within the tissues or poured out upon the wound-surfaces. This end is attained by establishing convenient outlets for such secretions, and by keeping these outlets open until the symptoms of local infection have subsided. But it is not likely that we will benefit our patients much in attempting to destroy the germs in wounds by the use of strong antiseptics. Recent investigations have shown that the germs contained in abscesses have to a great extent perished, and that the formation of pus is probably due to the irritation caused by their products. It follows that, if we can establish ample drainage for all such collections, there will be no occasion to treat them further with antiseptics. It will suffice to let them escape from the body. Nor does it seem rational to attempt the destruction of germs in the walls of cavities or sinuses by antiseptic irrigations, in which we will probably be successful to a small extent only, and then very likely in a mechanical way. It is still an open question, whether or not the removal of tissues infiltrated with pus and micro-organisms, perhaps already ne-

crotic, should always be undertaken in dealing with infected wounds. Some surgeons favor active interference, whereas others prefer to thoroughly expose such cavities, to insure free and permanent drainage, and to trust to the vital action of the neighboring tissues in overcoming the sources of infection still present. We must support this vital action, and not lessen it. I have already alluded to the fact that strong antiseptic fluids impair the vitality of the superficial layers of cells, when poured upon wounds. If this is the case in aseptic wounds, it is even more likely to occur in infected wounds, where the cells possess less vitality. If we consider irrigation necessary for the mechanical removal of secretions, we will, therefore, do better to employ in this instance also an aseptic fluid, preferably a sterilized salt solution.

The dressing of an infected wound should also favor free drainage. It is a better plan to pack such wounds with gauze than to rely on the action of drainage-tubes. The latter will occasionally be indispensable, when free exposure of wounds is impossible for other reasons, such as their depth and their situation near vital parts. But, whenever possible, such wounds should be laid and kept well open. This course has many advantages. It encourages evaporation of the secretions in the dressings, and about the wound-surfaces, inhibiting thereby the growth of micro-organisms. It further facilitates the entrance of air, and especially of oxygen, to wounds, which, we know from recent investigations, has a marked influence in retarding or suspending the development of most infectious germs, that have become anaerobes within the tissue of the body. Very likely the favorable action of peroxide of hydrogen on suppurating surfaces is due to the same cause.

Moist dressings are often of value in the treatment of infected wounds. When the discharges are viscid and ropy, they will not be readily absorbed by dry dressings. They will, moreover, evaporate, and thus give rise to the formation of scabs and crusts, under which stagnation of the secretions and a lively development of micro-organisms may go on. If, in addition to this, much infiltration of the wound-surfaces is present, moist dressings, frequently changed, answer an excellent purpose. They may act antiseptically to a certain extent, but their main purpose is to prevent exsiccation, and to keep the parts moist and warm. When infiltration and inflammation have subsided, and healthy granulation is beginning, the wound itself may be dressed with iodoform gauze over which a dry aseptic dressing is applied. The iodoform will stimulate granulation and lessen secretion. As the wound-cavity begins to fill up, special indications may arise for the treatment of the granulations. They may require stimulation, if sluggish—or cauterization, if exuberant—until finally the edges of the wound can unite over them, or the intervening gap can be closed by skin-grafting.

If irrigation with antiseptic fluids is at all indicated in modern wound-treatment, it is in the cleansing of fresh wounds proper, which have been contaminated with gross impurities. The conditions are different here from those which exist in wounds of which infection has taken a firm hold. No growth of germs, no infiltration of the walls of such wound-cavities with the latter, has yet occurred. There is a better chance of bringing the antiseptics into direct contact with the causes of infection and of preventing their further development in

these cases. But even here, antiseptic irrigation may be dispensed with. The cleansing of such wounds, including ample exposure with the knife, the removal of tissues which are much contused and lacerated, and of gross impurities, by irrigation, scraping, or excision, is a mechanical procedure. What we cannot remove in this manner we will not be likely to destroy with antiseptic irrigation, especially when the impurities, as is often the case, are ground into the tissues. These wounds will also, in all probability, heal as well under thorough *aseptic* cleansing and irrigation, followed by packing with iodoform-gauze, as when treated with strong germicidal solutions.

DISEASES COMPLICATING WOUNDS. ERYSIPELAS; SEPTICÆMIA AND PYÆMIA; HOSPITAL GANGRENE.

BY

OTTO G. T. KILIANI, M.D.,

INSTRUCTOR IN CLINICAL SURGERY AT THE NEW YORK POST-GRADUATE MEDICAL SCHOOL AND HOSPITAL, SURGEON TO THE GERMAN DISPENSARY.

I. ERYSIPELAS.

ERYSIPELAS[1] is a peculiar infectious and contagious inflammation of the skin and its lymphatic ducts, produced by the micro-organism known as the *streptococcus erysipelatis* (Fehleisen), and always originates in a lesion of the integument. It assumes the form of a sharply defined, spreading, and migrating redness, always accompanied by rise of temperature and the concurrent symptoms of fever.

HISTORY.—The history of erysipelas presents for several reasons a very interesting study, because it shows what tremendous progress we have made in the knowledge of the etiology of wound-complications, since bacteriology became a science. It is not saying too much to assert that Hippocrates (460–377 B.C.) was nearly as well acquainted with this disease as we were up to the middle of this century. This is surely true, as far as the clinical symptoms, diagnosis, and treatment of erysipelas are concerned, though in earlier times, doubtless, some other diseases of similar character were confounded with it. As to its etiology, we had to wait for men like Trousseau, Billroth, von Volkmann, Lister, Hüter, Klebs, and Koch, till finally Fehleisen, whose name has been given to the specific microbe of the affection, proved beyond doubt the origin of this well-known and much-dreaded disease. The immediate apparent result of this great discovery has shown itself not so much in the treatment of erysipelas where it is already present, as in the prophylactic measures to be adopted, a common feature of all the results so far gained in theoretical and experimental bacteriology.

Only for the student of medical history would it prove of interest to follow the different courses which the doctrines concerning erysipelas have taken in past centuries. It may be sufficient to say that Hippocrates, as stated above, in his third book of the Epidemics, gave an exact

[1] For synonyms and derivation of the word erysipelas, see Prof. Alfred Stillé's article in Vol. I.

description of erysipelatous affections originating from slight lesions, and destroying the skin in a great measure by gangrene. Diodorus and Thucydides, who was himself attacked by the disease, described excellently the "Attic plague," 430–425 B.C. Galen related the plague of Antoninus, 165–180 A.D., which raged from Persia to the Rhine, a great deal of which surely was malignant erysipelas. Afterward, in the fifteenth and sixteenth centuries, it seems that the definition and the limits of the disease were not as clearly understood, and it is well-nigh impossible to distinguish erysipelas from the many other diseases with which it was confounded. The prominent leeches of the sixteenth and seventeenth centuries believed with Galen and his pupils, that the genesis of erysipelas was accomplished through the agency of the bile (bilious erysipelas). Choleric and full-blooded individuals were specially susceptible; some physicians differentiated two forms of the disease, one in connection with the bile, "biliary blood," which offered a better prognosis than the other, which was observed at times "when an envenomed air prevailed."

This "mixtum compositum" grew worse and worse till the beginning of the present century, when the reports of epidemic erysipelas were of more value. Those outbreaks which occurred in all forms, from the mildest to the most malignant types, from 1830 to 1860, at different places in Europe—Scotland, Denmark, Germany—and in North America,[1] are specially interesting. European, and especially German, literature, which treats of other epidemics very fully, seems to have taken very little notice of those in the United States. Among the reports of American physicians, those of Drake, Peebles, Shipman, G. Sutton, Charles Hall, G. Dexter, and others, deserve our special attention. We find the first traces of this pandemic, especially of the so-called typhoid erysipelas, in Canada, in 1841, whence the affection spread over the whole territory of the United States, especially toward the southwest. The intensity and extent of this so-called typhoid erysipelas varied very much. Sometimes the disease occurred more or less generally at a place, while at other times the cases were only sporadic, or were restricted to hospitals. Drake, in his excellent treatise,[2] describes the course of the epidemic thus: After having started in the winter of 1826 in Burlington, Vt., in 1832 in Ogdensburg, N. Y., in the spring of 1833 and winter of 1836 in St. Clairsville, the general outbreak of the great scourge occurred in 1841, when the affection first manifested itself in Canada. Thence it came in the following year to New York and Vermont, and at the same time to Indiana. The winter of 1842–1843 brought it to Missouri and Ohio, and in the winter of 1843–1844 the epidemic reached its height and largest distribution in Canada, Wisconsin, New York, Indiana, Illinois, Kentucky, Tennessee, and Mississippi, while the following spring showed only Missouri, Alabama, Tennessee, and New York infected. In the latter states the epidemic slowly died out until 1849, so that in the winter of 1849–50 we find reports only from Vicksburg, New Orleans, and a few other places. The spread of the disease was from northeast to southwest, through fifteen degrees

[1] It may be said here that the first epidemic of erysipelas in the United States did not occur in 1843, as is generally believed, but that the epidemic of smallpox of 1699 was accompanied by erysipelas, as Haser, in his history of epidemic diseases, abundantly proves.

[2] Principal Diseases of the Interior Valley of North America.

of latitude; many places in the infected region remained entirely free from the contagion.

We must not forget, however, that a number of the highest authorities do not believe in the erysipelatous character of the epidemic just mentioned. Men like Hirsch and von Volkmann have grave doubts whether a good many of these cases were not more of a diphtheritic nature than truly erysipelatous. We must bear in mind that those who observed this epidemic had to base their diagnosis entirely on the clinical symptoms, and did not have the absolute bacteriological proof of its nature, so easily accessible to any student of medicine nowadays. Therefore, with all respect to the high abilities of the above-mentioned authorities, we have to leave in doubt whether some other diseases, especially diphtheria and dysentery, were not confounded with it, though it is beyond question that, if this be true, a great many cases were complicated by erysipelas; and it is only fair to mention that Tillmanns, in his admirable treatise on Erysipelas,[1] is all but convinced of the truly erysipelatous character of this most interesting epidemic, which is unparalleled in medical history.

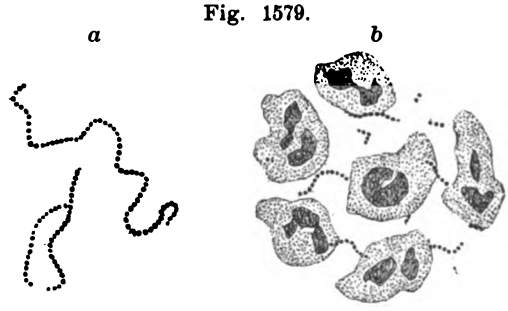
ETIOLOGY.—While in those times the clinical features and epidemic character of the disease excited the special interest of physicians, the question of the causative agent has come into prominence since the beginning of the bacteriological tendency in medicine. As has been the case with most of the infectious diseases, the bacteriological investigation of erysipelas has also been crowned with success. Its bacteriological nature was made probable by the discovery of cocci, found in the skin, lymph, and blood of patients with this disease, by von Volkmann, Wilde, Orth, von Recklinghausen, Lukowsky, and Tillmanns. This was in the decade from 1870 to 1880, when our modern ideas about the etiology of diseases had gained ground, though an absolute result was unattainable with the methods of examination then possessed. The reason why we could not get beyond the probability that the microbes which we saw were really the specific agents of erysipelas, was that the direct proof was still wanting. The latter was not possible till Koch's great discovery of a solid, transparent, culture medium (Nährboden), and the modern development of bacteriological technique by his agency, which permitted the differentiating of various bacteria occurring at one and the same time, and their cultivation in pure cultures which could be used for experiments on animals. After this was established, it was Fehleisen who brought forth, in 1882 and 1883, his streptococcus erysipelatis as the specific cause of the disease in question. This was proved beyond any reasonable doubt, as he could fulfil the three principal demands of Koch's doctrine. For he found the microbe constantly in the lymphatic system of erysipelatous skin; secondly, he could cultivate it in pure cultures outside of the human body; and lastly, he could generate erysipelas by inoculations with cultures not only in animals, but also, what is vastly more important, in man.

The exposition of the etiology of erysipelas is very simple and short, if we admit the modern point of view, and accept what the whole scientific world has accepted. The definition can be condensed into one short sentence: erysipelas is a wound-complication of the skin and

[1] Deutsche Chirurgie, Lieferung v., 1880.

mucous membranes, caused by the inoculation of the only specific agent, the streptococcus erysipelatis (Figs. 1579, 1580, 1581), into a lesion of these parts. Of course, it may be said that it is easy enough to set up a definition, and then to declare only those cases to be really erysipelas which answer the postulate, and exclude all others. But this objection is weak enough, because, after all, we have to confine ourselves to one definition of the disease, or we shall never be able to make the diagnosis. It is self-evident that a great many observers, otherwise perfectly reliable, deceived themselves and others by their reports, as long as they had to guess at the nature of the virus, and that they worked out hypotheses sometimes as ingenious as they were incorrect.

Fig. 1579.



a, Streptococcus erysipelatis. × 950. *b*, Pus with streptococcus. × 800.

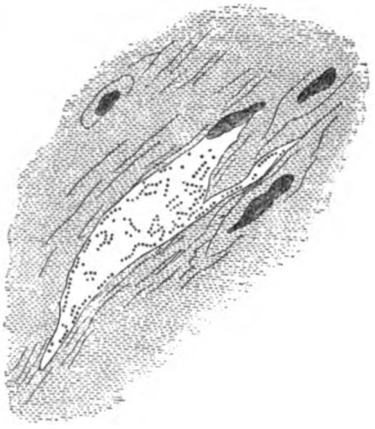
First of all, I must deny emphatically that there is anything like spontaneous erysipelas. In most of those cases which were claimed to be such, it is not very difficult to trace the source of infection, and in others it might have been easy enough to do so, if attention had been called to the way of infection. The locality where most cases of the so-called spontaneous erysipelas occur, is the face, that is, a part of the body which is exposed, uncovered, to wind and weather, and to other mechanical and chemical influences of all kinds. If the face were examined daily with a magnifying-glass, there would always be found lesions of the skin big enough for the invasion of the poison. Besides, a great many cases of erysipelas of the face represent a continuation of an erysipelas existing in the mucous membranes of the cavities of the head, especially of the nose. This fact has not been taken into consideration enough by the advocates of the spontaneous genesis of erysipelas. That this erysipelas of the mucous membranes of the nose is not spontaneous either, is a matter of course, easy enough to understand if it be remembered how many persons have the habit of boring the fingers into the nose, which is the most frequent source of erysipelas of the face. Furthermore, it must be considered that erysipelas does not necessarily start and make its appearance at the point where the lesion of the integument takes place. It quite frequently shows itself at a certain distance, the virus having wandered through the lymphatic ducts till it becomes established. How easily these first lesions, the place of entrance, may be overlooked, everybody knows who has the opportunity to observe other septic infections of a phlegmonous character. We see every day most severe phlegmons start from a little scratch, such, for instance, as butchers get from handling meat and bones. The cause of infection is clear enough here, though very often we are hardly able to find the

Fig. 1580.

Culture of streptococcus erysipelatis.

primary lesion. It frequently is healed up in from twenty-four to thirty-six hours, in spite of the infectious character of the disease, which is severe enough to infect other, more remote parts, or even the whole system. Or, to pick out another instance, we very often observe the so-called idiopathic bubo in the groin, an adenitis which has its cause in a badly cut corn of the toe, or in a slight soreness of the toes produced by hyperidrosis (sweating feet).

Fig. 1581.



Streptococci Erysipelatis. × 700. Section through a lymphatic duct of the skin. (Fluegge.)

It has been said that the possibility could not be denied *a priori*, that in rare cases erysipelas might originate in lesions of the digestive apparatus, the uterus, or the lungs, or, generally speaking, of the internal integuments of the body which communicate with the outer air. This, then, might produce a metastatic erysipelas of the skin. After careful study of the whole literature on this point, I am inclined to say that we have not a single reported case which proves with absolute certainty an infection in this way. Besides, the modern conception of erysipelas inclines strongly to the belief that there is no metastatic erysipelas, and that those metastatic cases which show most of the symptoms of true erysipelas have nothing to do with that disease.

The extremely interesting question whether the cocci of erysipelas can enter the body through its natural openings, the uninjured sudatory and mucous glands and hair follicles, is not as easy to decide. Since it has been shown experimentally that micro-organisms can leave the body through these natural openings, it cannot be denied, without further investigation, that they are able to enter by those channels. The experiments above alluded to proved the existence in the sweat of pigs of the same microbes with which they had previously been infected. Of course, the snout, through which alone the pig sweats, had been thoroughly disinfected, the animal being treated with pilocarpine, to produce profuse sweating. Besides, Garré, professor of surgery in the University of Tübingen, has proved with absolute certainty that infection by the staphylococcus pyogenes aureus through the uninjured skin, is possible. He took a small particle of pure culture of the coccus and rubbed it on his forearm, whereupon he got no less than twenty-nine furuncles of the severest kind, the experiment nearly costing him his life.

Erysipelas in coincidence with internal diseases, acute as well as chronic—as, for instance, typhoid, variola, varicella, intermittent fever, pneumonia, Bright's disease, cirrhosis, heart disease, intestinal disorders, etc.—used to prove of especial etiological interest. With our idea of erysipelas, we can hardly understand that such excellent observers as those who described these cases were not able to keep the two diseases apart, since they had nothing whatsoever to do with each other. This is one of the great results of our modern study of the etiology of diseases, that we know exactly the symptoms which can be produced by a specific

disease, and can differentiate other coincident symptoms which have nothing to do with the original malady, and can ascribe them to their proper causes. It cannot surprise us, to-day, that out of one hundred or one hundred and fifty patients with typhoid fever, some of whom will have bed-sores, one should develop the symptoms of erysipelas, starting, of course, from the ulcer; and we should never think of constructing a complicated explanation of this phenomenon. There is quite an extensive literature, with most exact statistics, about the concurrence of erysipelas with typhus abdominalis and typhus recurrens, which is entirely without value for us. We cannot be surprised, either, to find reports of erysipelas starting from the point of administration of a hypodermic injection, which is really a true bacteriological experiment of inoculation on man.

It is hardly necessary to go through the other diseases mentioned above, which may concur with erysipelas; but it seems to me that one point should not be omitted, and that is, the connection of erysipelas with puerperal fever. It is sufficient to mention the names of Ingleby, Hutchinson, Levergood, Clarke, Storrs, Simpson, Graves, Minor, Hincks Bird, Kneeland, Elkington, Hodge, Wilson, Spencer Wells, Squire, Tilbury Fox, Nunneley, Trousseau, Masson, Hadry, Virchow, Hirsch, Rust, and a great many others, to show what able authorities have directed their attention to this combination.

It is somewhat remarkable that not before our century was the identity of erysipelas with some forms of puerperal fever accepted, since it is eminently obvious that the puerperium is especially favorable to erysipelatous infection, if we only think of all the lesions, lacerations, and abrasions on the labia, in the vagina and cervix uteri, and specially of the large wound in the uterus itself at the insertion of the placenta. The close relations which are said to exist between erysipelas and puerperal fever may be formulated thus: Wherever the conditions in hospitals, lying-in hospitals, etc., are such that we find epidemics of puerperal fever, there is just as much chance for erysipelas as for any other wound-complications, so-called puerperal fever, septicæmia, etc., as all these infections are brought about, not by any impalpable virus, as poisonous air, but by bodily inoculation with hands, instruments, cloths, bandage-material, etc. The practical result of our study of this question is indeed a very beneficial one; every midwife and physician, who has a case of erysipelas in confinement, must know that she or he is alone responsible for it, if in charge of the case from the beginning. If nurses or physicians, who have treated cases of erysipelas, cannot avoid attending to confinements, they must be aware of the danger to their patients, and therefore disinfect their hands, clothes, etc., as rigidly as possible. All the reports about the occurrence of epidemics in hospitals of erysipelas and puerperal fever, explain themselves very easily to us by contact-infection; and that we are right in this explanation, is shown by the fact that we know how to avoid such epidemics to-day.

It can be of but little interest to us to follow studies about the occurrence and distribution of erysipelas, the influence of climate, season, weather, etc. It is enough to say, that erysipelas can and does occur anywhere on the face of the earth, and at any time. Surely, of just as little importance is the question of race, sex, and constitution.

In regard to the different parts of the body where erysipelas most frequently occurs, Bardeleben says that there are twenty cases of erysipelas of the head to one on other portions of the body. This is easily explained by the fact that, in the first place, the tender skin of the face is most exposed to injuries, and, on the other hand, that the scalp is the most difficult part of the body to clean. This is surely also the reason why erysipelas used to be especially dreaded, and of such frequent occurrence, after injuries of the scalp.

Hardly anything remains to be said about the epidemics and endemics of erysipelas. There is nothing mysterious about them, if we look at them from our point of view. Infection through the air surely occurred only in the rarest cases, if ever, while the mode of transportation of the virus was clearly by means of contact; first, by immediate contagion through the hands of a patient suffering with erysipelas, or of those attending upon him; next, the surroundings of a patient, as clothes, bedding, furniture, carpets, curtains, etc., through contact-infection became bearers of the virus, which was through this intermediate link communicated either directly or indirectly to other persons. To avoid endemics in hospitals, it is not only desirable but imperative to have everything prepared to isolate erysipelatous patients entirely, which means to have ready for them not only an entirely secluded pavilion or ward, but also separate physicians, nurses, etc. Several large modern hospitals, for instance the new State Hospital of Hamburg Eppendorf, have created the position of a so-called septic assistant, who, with his own staff of head-nurse and nurses, has entire charge of all septic cases, as of phlegmons, gangrene, erysipelas, etc. All the necessary operations are performed in a special operating-room in the septic ward, and the assistant is excluded from helping in or looking on at laparotomies. Under these circumstances, with the necessary care, an endemic in such a hospital is next to impossible. Not only this, but the general results of operations are much better, because the assistants are not exposed to infection from poisonous material.

We cannot omit the question of recurrence of erysipelas. It is a disease which surely has such a tendency, but it is hard to give exact figures of frequency of recurrence, as statistics, especially in this line, are bound to be unreliable. But 5 per cent. seems to be about the right number. As to the etiology of recurrences, it is without question that the greater part of the so-called recurrences which come to our observation shortly after the primary infection, are nothing but its late manifestations, while some of the later recurrences may be traced to new infections. In spite of all this, some persons show for a number of years a striking disposition to infection by erysipelas, and they are attacked for five, ten, fifteen years, and longer, once or several times every year. This is the so-called habitual erysipelas. Nearly always these patients show local alterations whence the erysipelas starts; as such we find chronic pustulous or ulcerous affections somewhere in the skin, chronic suppuration of glands in scrofulous individuals, chronic eczemas of the face, at the introitus of the nose, at the lips, ulcerous or catarrhal processes in the nose, pharynx, or mouth, affections of the ear, suppurating processes of the tympanic cavity, with perforation of the tympanum, affections of the neighborhood of the eyelids or lachrymal sac, varicose veins or varicose ulcers,

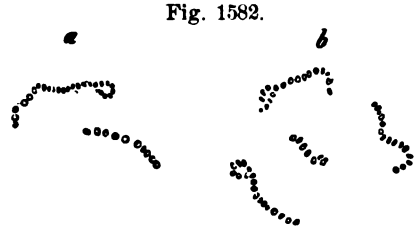
eczemas of the lower extremities, etc. Moreover, we must not forget that other diseases are frequently mistaken for erysipelas, as for instance, those erythemas which occur after eating crayfish, crabs, lobsters, fish-liver, mushrooms, strawberries, etc., as well as herpes zoster and gouty eczemas of the skin.

SYMPTOMS, DIAGNOSIS, AND PROGNOSIS.—The clinical picture of the so-called legitimate erysipelas of the skin, without complications, is in typical cases characterized by an acute, rapid rise of temperature, mostly up to high degrees, developing simultaneously with erysipelatous inflammation of the skin, and a correspondingly rapid disappearance of the feverish symptoms, with an acute declination to normal temperature, or below it, as soon as the local inflammation ceases.

The local inflammation is so typical, that it is impossible, after having seen it once, to overlook it or to mistake it for something else, in well-developed cases. As mentioned before, it starts from a small lesion in the skin, which may even, at the time the erysipelas is observed, be healed up. In its nearest neighborhood, we either find red dots, which merge into each other after a short time, or we find one continuous reddened surface. The color varies from brick-red to dark-red or livid. The surface of the inflamed part is slightly swollen, and therefore higher than the surrounding skin. The outlines of the affected spot are usually irregular, sometimes tongue-shaped peninsulas projecting quite far. One of the typical features is that the boundaries where the reddening stops and the apparently sound skin begins, are in most cases very sharply defined. During its progress the inflammation wanders, that is, the disease not only affects new parts by pushing forward its outer boundaries, but the affected spot *in toto* changes its location, the inner frontiers apparently being absorbed, a condition which cannot be better described than by comparing it with the way in which spilt burning alcohol moves along, or in which, according to Volkmann, a sheet of paper is devoured by a fire starting at its edge. The erysipelatous reddening is accompanied by a more or less developed doughy swelling, that is, a serous transudation in skin and subcutaneous tissue. The redness disappears on pressure, but reappears again immediately, while the transudation pressed away by the finger cannot come back as quickly as the redness; therefore a small dent remains. Owing to the increased flow of blood to the infected spot, the latter feels hot to the touch. According to the degree of the swelling, which gives the skin a shiny, more or less tense appearance, the pain is usually tolerable, but increases much on pressure. The greatest transudation is found in the lids, lips, scrotum, penis, labia, and vulva, and then on the ears, toes, fingers, point of the nose, etc. The serous imbibition of superficial strata of the skin and the rete Malpighii produces not rarely blisters in the epidermis, with serous contents, which in the beginning are absolutely clear, or yellow, but after a short time may grow turbid and purulent. The blisters usually dry up rather quickly, forming crusts. We then find sometimes, under the latter, superficial suppuration, which only in rare cases of more malignant character progresses toward the deeper tissues, especially if the erysipelas is complicated with phlegmonous symptoms. It is hard to draw the line between erysipelas and other wound complications, if we have to deal

with phlegmons and gangrene. It is the more difficult, as we have no means by which to discriminate distinctly between Fehleisen's coccus of erysipelas and the usual streptococcus pyogenes, a differentiation which has been given up entirely by most bacteriologists. Therefore, phlegmonous and gangrenous erysipelas very often has nothing at all to do with erysipelas proper, but comes under the head of septicæmia and pyæmia. If we read the histories of the cases reported by von Pitha, which are generally declared to give most exact and definite descriptions of this form of erysipelas, we cannot be in doubt that we should class all these cases nowadays as examples of septicæmia.

Fig. 1582.

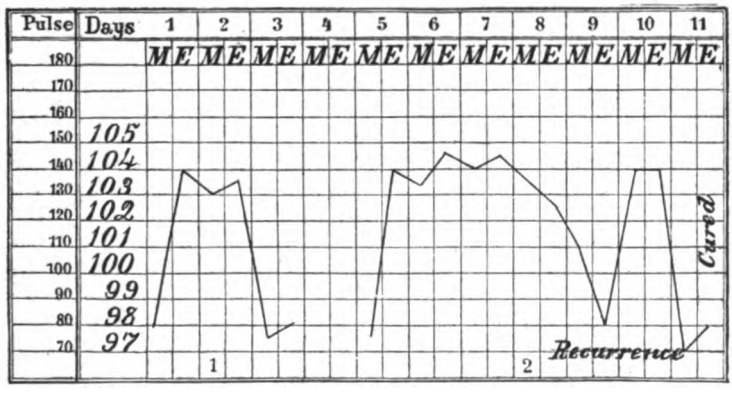


Chains of Cocci. *a*, Cocci of erysipelas; *b*, cocci of phlegmonous inflammation. (After Rosenbach.) × 902.

Nevertheless, there are a number of cases which must be classed, not as instances of mixed infection, but as cases of true, genuine erysipelas. The explanation of the formation of abscesses has to be given in the following manner: the usual way for propagation of erysipelas being by the lymphatic ducts, we usually see erysipelas spread on the surface, but if the cocci get into the blood, as it has been proven that they do in some cases, the formation of abscesses in the tissues surrounding the primary spot of infection, or even at more or less remote places, cannot be surprising. We must, however, always bear in mind that this is not the usual course, but an exception to the rule.

The rapidity with which erysipelatous inflammation spreads is very variable; sometimes it moves within twenty-four hours from half an inch to an inch, sometimes as much as ten inches. In typical, uncomplicated cases, which are by far the most frequent, inflammatory red-

Fig. 1583.



No. 1.—Fever-curve of erysipelas of two days' duration, with typical quick defervescence. No. 2.—Fever-curve of erysipelas with recurrence after transient defervescence. Cure.

dening and swelling pass into a complete *restitutio ad integrum*, without leaving any trace whatsoever of the process which has taken place. Sometimes, however, abscesses are formed even in the deeper layers of tissue, but only in cases of mixed infection by streptococci and other bacteria.

The general condition of the patient corresponds to the intensity and extent of the local erysipelatous affection. The temperature (Fig. 1583) suddenly, with acute violence, goes up to 104° F., or more, accompanied by one or several chills, and just as quickly sinks again to the normal, when the affection is over. As long as the erysipelas subsists, the temperature at the height of the attack varies mostly between 104° and 106°. Sometimes, immediately after coming down to the normal, it rises again at once to its former height, which is usually thought to indicate a recurrence, a term which does not quite cover the facts.

The other symptoms are those which usually accompany any high fever; thus, the region of the stomach and liver are sensitive to the touch, and there are lack of appetite, nausea and vomiting, great thirst, a furred, dry tongue, etc. The spleen is often enlarged, the region of the kidneys is not rarely tender to the touch, the urine is mostly dark colored, and contains albumin, blood or gall-pigment, and micrococci. The quantity of urine is lessened. A fatal result in erysipelas either is due to the general poisoning of the system by ptomaines, or ensues because a vital organ, as for instance the cavity of the skull, has been attacked.

It is easy to understand that the duration of erysipelas cannot be to any extent uniform. There are cases of erysipelas, with no doubt in the diagnosis, which last twenty-four hours or even less, while others persist for several weeks, with changing intensity and so-called recurrences, sometimes even the same places being invaded and covered again and again by the inflammation. The average duration is from six to eight days, and every case of erysipelas lasting longer than two weeks is, as Billroth says, an exception.

Besides the more frequent complications, as formation of abscess, etc., we have to mention others of more or less rarity. Of special interest are those of the eye, which may occur in manifold forms, as, for instance, impairment of acuteness of vision, transient blindness (very rare), panophthalmia with atrophy or suppuration of the bulb—which occurs particularly when an erysipelas of the face attacks the orbital cellular tissues—turbidity of the optic media, iritis, ulcerative processes of the cornea, retinitis, and optic neuritis with atrophy of the optic nerve. Erysipelas of the head is sometimes complicated by catarrhs and suppurative processes of the auditory tract, inflammations and suppurations of the parotid, difficulty in swallowing, and occasionally diphtheritic lesions of the pharynx. The so-called erysipelatous pneumonia must be strictly discriminated from ordinary pneumonia and bronchitis in erysipelas; while the latter, especially bronchitis, are of very common occurrence in any severe erysipelas, the so-called erysipelatous or wandering pneumonia has, very likely, no connection whatever with that disease. It seems as if the clinical similarity in the course of the skin-affection and that of this special malady of the lungs had led to the name, without any real reference to its etiology. Of course, it cannot be entirely denied that in some cases erysipelas of the pharynx may progress downward in its course, and attack the bronchi and, in time, the capillaries of the lungs.

If we mention the occurrence of icterus (jaundice), caused by gastric disorders or occurring in its hæmatogenous form in severe cases of erysipelas, and nephritis, which in the very worst cases may lead to uræ-

mia, there is nothing left except the very interesting appearance of ulcers in the small intestine, and of transitory hyperæmia of the mucous membrane of the gut, with hemorrhagic diarrhœa.

We have also to speak shortly of erysipelas of the mucous membranes, which doubtless occurs, and the course of which is very analogous to the course of erysipelas of the skin. The only difference is the great difficulty in the diagnosis of erysipelas of the mucous membranes, which really cannot be made with any certainty until the disease has passed over to the cutis, and there shown its typical symptoms. This difficulty makes it more than probable that a great many of these cases have really very little or nothing to do with erysipelas, which has been mixed up with diphtheria, pyæmia, and other acute infectious diseases. The favorite places of erysipelas of the mucous membranes are the cavity of the mouth, with its adnexa—nose, pharynx, larynx, etc.—the female genital tract, and the rectum. There are also cases reported where ulcers in the antrum of Highmore, and in the sphenoid and ethmoid cavities, gave rise to erysipelas, which was recognized as such when it made its appearance upon the skin.

Of the first group, erysipelas of the pharynx with its complications, especially œdema of the glottis, is most dreaded. Glottic œdema in erysipelas seems to be mostly fatal, in spite of intubation and tracheotomy. An explanation of this can only be found in the fact that the serous infiltration of the mucous and submucous cellular tissue in the region of the epiglottis, ary-epiglottic ligament, etc., is transformed into pus, leading to fatal septic and pyæmic symptoms. Or fatal cachexia may be caused by extensive suppuration of the larynx itself. Besides this, the usual dangers, as in diphtheria, such as poisoning by carbonic acid, and its consequences, come into consideration.

The second group occurs especially in the puerperium; I have mentioned above the many lesions which delivery brings about, from any of which erysipelas may start. It is, of course, a contact-infection, like all the others, a fact which has led modern physicians to avoid internal manual examination, during delivery, as much as possible. All that has been said of erysipelas in other organs might be repeated here, with only slight modifications. The danger of mistaking other infections, especially pyæmia, for erysipelas, is very great. There is one point which is characteristic of erysipelas in the puerperium, which is the possibility of an infection by way of the milk from the mother to the child, streptococci having been found in the milk. Another fact to be mentioned is, that an erysipelatous infection, starting from the genital tract of the mother, during the last days of pregnancy or even in the beginning of delivery, may be transferred *intra uterum* from mother to fœtus, by way of the lymphatic ducts.

The *diagnosis* of well-developed ordinary erysipelas of the cutis is, in typical cases, very easy and hardly to be mistaken. All the characteristic local symptoms mentioned above, especially the local reddening and swelling of the skin, with the acute rise of temperature, and the course of the disease, already described, are so well-marked that any one who has seen them once will not fail to recognize them again.

The *prognosis* of erysipelas is generally not unfavorable, but, since we have no absolutely reliable means by which to stop its propagation, as will appear hereafter, we cannot guarantee a favorable result, even

in apparently slight cases. The prognosis depends upon a great many circumstances, such as, especially, the location of the affection, its duration and extent, the constitution and age of the patient, the intensity of the fever, etc. The rate of mortality has been very differently reported by different authors, but 11 per cent. seems to be about the right figure, taking into consideration Zülzer's statistics and those of American physicians, based upon a large number of cases.

For the sake of completeness, I must mention here the so-called zoönotic erysipeloid, or wandering erythema (erythema migrans) of the fingers and hands. Etiologically, it really has nothing to do with true erysipelas, as it is caused, according to Rosenbach's investigations, by a particular micrococcus, larger than a staphylococcus, of special qualities, which seems to have much analogy with Cohn's cladothrix dichotoma. It especially attacks individuals whose occupation brings them in contact with dead animal substances, such as, dealers in fish and game, cooks, oyster-openers, barkeepers, butchers, tanners, and dealers in cheese and herrings. Its clinical course is entirely different, as it always occurs without fever, and almost without exception stops at the wrist. It is often quite persistent, lasting sometimes from three to four or six weeks, while other cases disappear spontaneously in one or two weeks. Its rational treatment consists in an injection of a two-per-cent. solution of carbolic acid into the inflamed skin, especially at its boundaries.

TREATMENT.—We have no remedy which is even reasonably reliable against erysipelas. This somewhat striking assertion is proved by the enormous number of medicaments or methods of treatment which are recommended. Whenever this is the case with a disease, it is self-evident that none of the would-be remedies is reliable, or there would be no reason to try new ones.

Quite often an infallible remedy has been supposed to have been discovered, but has soon proved to be a deception. This is very possible, especially with erysipelas, as we have in this case to deal with a disease of entirely inconstant and untypical duration and intensity. We know that there are cases which last only for a few hours, and some which last for weeks. So we understand how little we may trust in the so-called abortive methods. It is quite out of the question even to mention all the "remedies" employed in earlier years. They vary from the use of a hot flat-iron and leeches, to the employment of oils, lard, glycerin, chalk, flour, milk, brandy, water, decoctions of lilacs, poppy-seed, all sorts of salves, the thermo-cautery, and vesicatories. But these were only external remedies; to recount those for internal use would be impossible.

The *internal treatment* of erysipelas has to be mostly symptomatic, since all efforts to find a specific remedy for erysipelas have been in vain. In light, uncomplicated cases, treatment is unnecessary; adequate diet, care for the proper function of the bowels, plenty of fresh air, and perhaps a mild laxative, are sufficient. It is not to be recommended to treat patients with erysipelas antiphlogistically, as the bodily strength may be needed very badly, and sudden lowering of the temperature may cause a fatal collapse. The most important factor in the treatment of erysipelas is the use of alcohol, strong wine, beer,

whiskey, brandy, or champagne, with strong, nourishing, but easily digestible food. I want to call attention to the necessity of giving these stimulants early, and not only when collapse has set in. At Volkmann's Clinic, it was usual to give quite large doses of alcohol, from forty to one hundred grammes daily (with equal parts of syrup and an aromatic water), which dose was sometimes increased considerably for heavy drinkers. It remains to be said, that Volkmann avoided alcohol in cases with very high temperature and absolutely dry skin, while nervous complications, like delirium, do not contraindicate its employment. Beside alcohol, quinine, or iron, perhaps also camphor, may be used. English authors especially emphasize the use of iron very strongly, and many of them call it a specific against erysipelas. It is hard to understand its effect, if we do not accept the explanation that the ptomaines of the cocci of erysipelas have a deleterious influence on the red blood-corpuscles and deprive them of their hæmoglobin. The different forms in which iron is given are the tincture and solution of ferric chloride, which were recommended in large doses by Hamilton Bell, the solution of ferrous chloride, and the bromide of iron. Bell's tincture was usually given in doses of fifteen or twenty drops in water, every two hours, and in very severe cases twenty-five drops every two hours, day and night; for babies, two drops in sweetened water every two hours. About the same dose of the other compounds of iron was employed, only given in gruel, instead of in water.

Beside iron, oil of turpentine, tincture of aconite, ergot, iodide of potassium, chlorine water, and belladonna have been given. For the complications, especially the gastric symptoms, emetics were administered as early as possible; for high fever, camphor, large doses of quinine, digitalis, veratrine, salicylate of sodium, cold baths, etc., were especially recommended. Pirogoff was especially emphatic in the recommendation of camphor, while others, like Thiersch, Burckhardt, Volkmann, Busch, Oettingen, and Spörer have not observed its much-vaunted results. In regard to the remedies just mentioned for the fever, I may say that Volkmann was generally not in favor of trying to check or reduce it, as he thought that the fever was a natural reaction and "self-help" of the organism against the invasion. This idea does not seem to be very wrong, since we know from experiments that most of the micro-organisms find their most favorable conditions in the normal temperature of the body, and that many of them can endure quite low temperatures—living bacteria can exist in ice—but can stand an elevation of the temperature above the normal even by a few degrees, for only a very short time. Only in exceptional cases is the height of the fever itself of immediate danger to the patient, and many surgeons, at least, do not acknowledge that they have ever lost patients by high fever; they claim that not the temperature has been fatal to the living cell, but the toxic effects, which we cannot counteract.

The narcotics, opium, morphine, chloral, sulfonal, etc., are of great value if the patient becomes very restless and excited, but they must be given in large doses, since small ones only intensify the febrile excitement, instead of inducing rest and sleep. Wherever it becomes necessary to lower the excessive temperature, cold baths are surely the best and most reliable remedy, being also one which acts promptly.

As manifold as the internal remedies for erysipelas are those for *local*

treatment. Of late, greater stress has been laid by most surgeons on external applications. To begin with the simplest of these, elevation of the affected part is certainly of some value; in cases of erysipelas of the fingers or scrotum, we can thus avoid gangrene. Then oil, grease, vaseline, and powders in all forms have been applied. Hebra recommended the extensive use of ice, while his followers went so far as to freeze, so to speak, the infected spot. In spite of Hebra's favorable results with this treatment, it is beyond question that gangrene sets in more easily when the vitality of the tissues is thus lowered. Theoretically, it was a decided step forward, when the attempt was made to destroy the poison produced by the cocci of erysipelas *in loco* by the hypodermic injection of remedies. Everything has been tried for this purpose, beginning with carbolic acid and like antiseptic solutions, ergotine, quinine, morphine, etc. The results of this treatment have been varied, and at present the method seems to be used only to a very small extent. Starting from the same theoretical idea which led to the hypodermic injection of carbolic acid, inunction with turpentine was recommended by Lücke and others. Besides this, the use of tar and mercurial ointment was advocated. Of other remedies which are still in use, we have to name Churchill's tincture of iodine, nitrate of silver, and collodion. Some absolutely reliable authors recommend the tincture of iodine very strongly, but dwell specially upon the fact that this remedy must be used very energetically. We must not forget, however, that its application is extremely painful, and is surely contraindicated in the severer cases of erysipelas, with tendency to gangrene and phlegmon. Nitrate of silver has been employed in different forms, but is applicable only in certain portions of the body. The important point is, that that part of the skin to which the remedy is to be applied shall be thoroughly freed from fat, and that not only the reddened portion shall be thoroughly treated, but also the adjacent parts. Some years ago, Volkmann had entirely given up the use of solutions of less than ten per cent. in strength, and applied exclusively and energetically the caustic pencil. The theoretical explanation given for its use is, that the nitrate of silver produces an infiltration of small cells in the part surrounding the seat of infection, forming as it were a wall of living cells of the greatest vitality, which the erysipelas coccus cannot overcome. Collodion, which was used for quite a long time, seems to have been given up entirely till very recently, when Niehans, Sacho, Schneider, and Ratcliffe have recommended it emphatically. Its effect is explained simply by mechanical constriction. It should be avoided on the scalp, whence it is very hard to get it off again, and of course on the eyelids, where its application has been reported to have once caused panophthalmia. It is needless to mention more fully the use of the thermocautery, as it has been abandoned entirely; but scarifications seem to be of the highest value, especially if they are applied in the way which is known as Kraske-Riedel's method.

This consists in making cuts somewhat like a worm-fence, from one and one-half to two inches in length, which form an enclosure entirely around the affected spot, at a distance of at least one inch, if possible, from the latter. Special attention must be paid that each cut crosses the two adjacent ones, so that the skin on the one side is really fenced off from the other. After this has been done, and the wound has bled

freely, which is only advantageous, a 1–500, or 1–1000 corrosive-sublimate solution is rubbed in with some force. Then a bandage wet with the same solution is applied, and must be changed every six hours. Of course, this method is limited to the extremities and the trunk. The cuts should not be deeper than just to penetrate the integument, and should not go down as far as the subcutaneous fat. Of all the modes of treatment which I have used and seen used, Kraske-Riedel's seems to be the most valuable. Special stress must be laid, however, upon operating only in healthy tissue, which is the more important as it is well known that the infection has commonly progressed farther under the cuticle than the surface-inflammation shows. Wherever the fence is too near, we find that the erysipelas has broken through; that is, it existed already, before the operation, in the lower strata of the epidermis, and simply became apparent on the surface on the following day. Whereever such a break occurs, it is sufficient to draw a semicircular series of similarly crossed cuts around the new tongue-shaped place, starting and ending in the original enclosure. As to the way in which this operation influences erysipelas, I have more confidence in its quality of dividing the continuity of the skin, than in the action of the antiseptic which is applied afterwards. Although the latter may contribute to the wholesome effect, the cutting of the lymphatic ducts, through which the infection principally spreads, mechanically stops its progress.

Where this method cannot be applied, as for instance in the frequent cases of erysipelas of the head, properly applied compression by means of adhesive plaster or a rubber bandage shows good results. If the infection starts, for instance, from the nose, the whole head, with men, is shaved, while with women only a circular band of hair, about an inch wide, is shaved out. With the hard skull as a basis, we have an excellent chance to use compression on the skin threatened by the adjacent erysipelas, whose spread seems to be actually stopped by this method. The theoretical explanation of its action is the same as that of Kraske-Riedel's method, the continuity of a vessel being severed by thorough compression as well as by cutting.

Effect of Erysipelas on Neoplasms.—It has long since been observed that intercurrent erysipelas of the skin has sometimes a striking influence on neoplasms, particularly of lupous and syphilitic nature, with or without ulceration, and then, especially, on genuine tumors, for instance sarcoma and carcinoma (so-called curative erysipelas). It has been noticed that the above-mentioned affections disappear lastingly, that long-existing ulcers and chronic diseases of the skin grow better, and sometimes even heal after accidental erysipelas has travelled over the affected surface. French authors call this very aptly "erysipèle salutaire," and we find many reports of such cases (W. Busch, Biedert, Schwimmer, Janicke, Neisser, P. Bruns, Langenbuch, Tillmanns, and others). While the results in lupus, syphilis, and other ulcerous affections, have proved to be inconstant and only of temporary value, the closer study of the influence of erysipelas upon carcinoma, and especially on sarcoma in its different forms, has proved to be of the highest interest. W. Busch has shown that even large tumors, especially sarcomas and lympho-sarcomas, may undergo, under the influence of erysipelas, a rapid fatty metamorphosis, and thus be absorbed and entirely disappear.

It is easy to understand why this most remarkable relation between erysipelas and malignant tumors, against which only too often even the most heroic operations are of no avail, has not led to the systematic treatment of these tumors with erysipelas; because until recently we had to produce genuine erysipelas, which was entirely beyond our control as soon as it made its appearance, and which sometimes killed the patient instead of curing him.

Lately, however, C. H. H. Spronck (Utrecht) has published in the Annales de l'Institut Pasteur, for October, 1892, a series of 26 cases of malignant tumor, which he and his co-operators have treated with a preparation of the toxic products of erysipelas, obtained in the same way as that by which Koch prepared his tuberculin. Before this, Rogers published in the Revue de Médecine, for December, 1891, his experiments on animals with heated or filtered cultures. William B. Coley (New York) has also made experiments with filtered toxines (obtained in the usual way through clay filters by suction), and has published his results in papers in the American Journal of the Medical Sciences, for May, 1893, and the Post-Graduate (New York) for August of the same year.

His latest report of 35 cases of malignant, inoperable tumors treated with the toxic products of erysipelas and the bacillus prodigiosus, are to be found in the Transactions of the American Surgical Association for 1894. While the author seemed to be very enthusiastic about his results, W. W. Keen, Roswell Park, and others, in discussing the paper, said that in the cases in which they had made injections with the extract furnished by Dr. Coley himself, they had been unable to obtain any cures. This has also been my own experience, in the few cases which I have had occasion to observe. Nevertheless, these investigations are of the greatest importance, and invite further research, as they show at least the possibility of curing even the most malignant tumors.

II. Septicæmia and Pyæmia.

There is such confusion in the nomenclature of these affections, and so much discussion about the etymological correctness of the different expressions used for the same disease, that I cannot do more than mention all the different names, and leave it to the reader to select that which he likes best, or to which he is most accustomed.

Piorry first used the expression *septico-émie*, from which all other writers, especially German authors, have derived the following different expressions: Septicæmie, septichæmie, and septikæmie. The roots of all these words are σηπτικός, a word used by Athenæus and by Aristotle, and signifying "rotten," and αἷμα, "blood." Virchow changed septicæmie into septhæmie, and subsequently into sephthæmie. Each of these names has been adopted by some of the authors on the subject, most employing the term *septicœmia*, but a great many surgeons prefer the simple, if not correct, expression *sepsis* to cover the whole subject.

There is less difference of opinion about the word *pycemia*, which, perhaps more correctly, might be changed into pyohæmia.

At the present day, when more stress is laid upon the etiology of diseases than upon their clinical symptoms, we have given up trying

to differentiate closely between the two affections in question, and we find, therefore, in modern treatises, the expression septico-pyæmia, which includes both.

SEPTICÆMIA.

Septicæmia is an affection of the general system, which originates by the reception into the body of the products of putrefaction, and is characterized by a certain change in the blood, a typical series of inflammatory processes, and a continued fever with typical nervous symptoms. It usually does not lead to the occurrence of metastatic suppuration, which is characteristic of pyæmia, nosologically so closely connected with it. It is a remarkable feature in the history of the literature of these allied affections that most of it was written when its authors necessarily knew least about the subject, mainly between the years 1820 and 1880. It is true that the writers of those times knew practically and clinically a good deal more than we do in these days; on the other hand, it did not help them much to observe daily, again and again, those unfortunate cases of sepsis, pyæmia, and hospital fever, as long as it did not lead them to a correct conception of their etiology. Most clever and most absurd ideas were brought forward in explanation of these, and it might make a man despair of the development of human science to see how the most ingenious writers were unable for years to anticipate their real cause, and, if we had not the practical proof of the correctness of our modern views, in the possibility of avoiding these wound-complications, it would be only natural to question their finality.

ETIOLOGY.—The etiology of septicæmia probably was closely studied before that of all other wound infections. Virchow, Billroth, C. O. Weber, and others experimentally produced septicæmia by inoculation of putrid material into the vascular system or into the tissues, and it was the development of sepsis which led to the acknowledgment of the importance of micro-organisms, which were first recognized as producers of fermentation and putrefaction. Panum, of Denmark, showed that analogous septic diseases could also be produced by the injection of boiled putrid fluids, that is, after all the micro-organisms which were originally contained in them had been destroyed, so that only their toxic products could remain. Therefore we distinguish now two differing principal forms of septicæmia, one caused by schizomycetes, and the other by chemical toxines in solution. The first form, produced by the presence of bacteria, is an infectious disease, transferable to other individuals; if we inject the blood of animals thus affected into others, we reproduce the affection. The virulence of the blood increases with the number of intermediate links, that is, with the frequency with which the disease is transferred from one animal to another (Coze, Faltz, Davaine, Magendie, Petrone, and others).

The blood in the second form of septicæmia, which is produced by chemical poisons in solution or in volatile form, that is, by the toxines produced by the schizomycetes, is not infectious, any more than is the blood of an individual poisoned with strychnia or prussic acid.

Personally, I fail to see the marked difference between these two

forms, and they seem to me rather to be two different stages of the same disease than two really distinct affections. If we disregard those cases of experimental septicæmia in animals, in which death ensues simply from the enormous quantity of bacteria—which is entirely unlike the condition prevailing in man, where we usually find only comparatively few micro-organisms—we have to seek the cause of death always in the toxic effects of the products of the bacteria, with the only difference that in one case the bacteria are still present, while in the other they have perished in their own products. The difference as to the infectiousness of the two different kinds of blood may be explained, I think, in the following way. In the first case, where living bacteria are present, the injected blood effects its results by the toxines produced in the original concentration, so to speak, by the meanwhile largely multiplied bacteria; while in the second case, where living bacteria are no longer present, we have only as much of the poison as is contained in the minute quantity of blood injected. This will be diluted in the whole quantity of blood possessed by the second animal, and will, of course, not multiply. This explains why we succeed in producing local septic conditions only, like abscesses, etc., and never a generalization of sepsis, by injecting chemical poisons, as for instance quicksilver, turpentine, sterilized pus, or putrid matter in which the bacteria have been destroyed.

Besides, there are surely between the septic poisoning by toxines and the bacterial septicæmia, quite a number of connecting, combined forms; for instance, we sometimes find in a case of septic poisoning schizomycetes of different kinds in the blood.

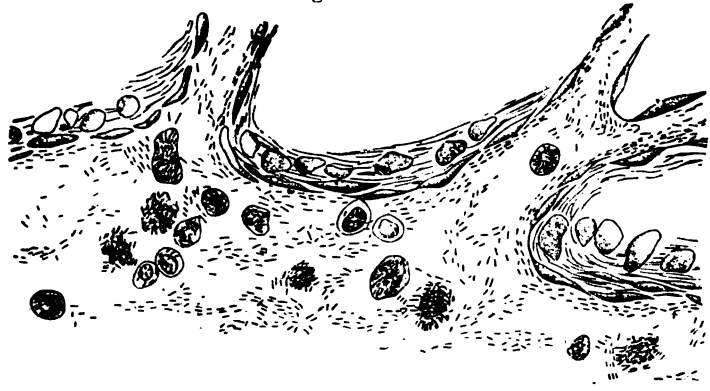
The conditions and actions prevalent in putrefaction are of the highest interest in connection with the etiology of septicæmia. The putrefaction of albumin in the presence of bacteria produces certain chemical substances, especially peptones and allied combinations, then nitrogenous bases (leucin, thyrosin, amines), organic fatty acids, aromatic products, coloring matter, and especially poisonous toxalbumins and certain alkaloids, comprised under the name of cadaveric alkaloids or ptomaines. The latter possess highly toxic qualities, as has been known for a long time. Panum isolated in 1863 the "putrid poison" from decaying matter; von Bergmann and Schneideberg a crystalline body, the sepsine; Billroth the zymoid of putrefaction. Selmi first characterized the nature of these bodies, and called them cadaveric alkaloids or ptomaines; then von Nencki first succeeded in producing in chemically pure form one cadaveric alkaloid, collidine, and indicated its formula. After that Etard, Gautier, Zuelzer, Schmiedeberg, Harnack, Angerer, Maas, and especially Brieger, investigated closely the ptomaines and toxines, several of which Brieger educed in a chemically pure form out of bacterial cultures, as for instance peptotoxines, neurin, neuridin, cholin, and others. The cultures of bacilli of cholera, typhoid fever, and tetanus, furnished him also toxines in the highest degree poisonous, their toxic character being clearly shown by the inoculation of animals. Some of the ptomaines or toxines produce an effect like morphine, curare, or atropine. The peptotoxine (Brieger) kills animals experimented upon with symptoms of paralysis, while the highly poisonous neurin excites, like muscarine, salivation, contraction of the pupils, irritation of the respiratory and vascular systems, and clonic convulsions. This explains

several forms of general intoxication after infection by bacteria starting from wounds, and partly the poisoning by decayed food containing ptomaines (meat, sausage, milk, cheese, fish, oysters, and clams). By filtration through clay-cells, we are able to isolate the toxines from the bacteria, so that we can study, by injecting the former into animals, their poisonous qualities, producing, for instance, severe gastro-enteritis (typhoid condition), nervous symptoms, convulsions, etc. If we destroy the micro-organisms in a bacterial culture by heating it above 60° C. (140° F.), we are able to study the poisonous qualities of some ptomaines, while the toxalbumins are destroyed. The kind and composition of nutrient media have some influence on the formation of these toxines, that is, the same genus of bacteria produces different toxines on different media.

Septicæmia in man is originated sometimes by bacilli, sometimes by cocci, among the latter, especially, the streptococcus pyogenes, the streptococcus septicus (Flügge), and the staphylococcus aureus. Ogstolm and Rosenbach found in cases of progressive, gangrenous phlegmon, with fatal sepsis, the streptococcus pyogenes as cause of the septicæmia. In cases of septicæmia consequent upon progressive gangrenous emphysema (gangrène gazeuse), Chauveau, Arloing, Brieger, Ehrlich, and Rosenbach found the same bacilli which were recognized by Koch as promoters of malignant œdema, a disease quickly fatal to mice, Guinea-pigs, and rabbits. These bacilli of œdema, which were formerly named *vibrions septiques* by Pasteur, are similar in form to those of anthrax. Of special interest are cases of sepsis consequent upon old or fresh endocarditis with embolism of microbes from old or fresh excrescences, on which micro-organisms, the streptococcus, for example, have been colonized out of the blood.

Our knowledge of artificial septicæmia in animals is more exact, thanks to Koch's experiments, than is our knowledge of human septicæ-

Fig. 1584.



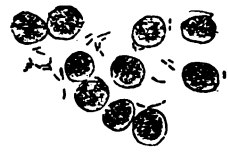
Bacilli of Septicæmia in a Diaphragmatic Vein of a Septicæmic Mouse. Leucocytes, partly containing bacilli, partly changed into heaps of bacilli. × 700. (R. Koch.)

mia. Here we may also distinguish between a toxic septicæmia (septic intoxication) and a bacterial septicæmia (transferable septic infection). The toxic septicæmia is observed after injection of large quantities of purulent substances into the subcutaneous cellular tissue; immediately, or soon after the injection, restlessness, weakness of motion, then

convulsions, often vomiting, and paralysis ensue, and are not seldom followed, a few hours after the infection, by death from paralysis of the respiratory organs. No bacteria are found in the blood or in the internal viscera. If putrid liquids containing bacteria are kept twenty-four hours in the incubator at a temperature of 40° C. (104° F.) their infectiousness is very great, but after forty-eight hours they have no effect whatever (Petrone).

In the bacterial septicæmic infection, great quantities of bacteria are found, especially in the blood, but also in the tissues. Koch described two kinds of bacterial septicæmia, that of mice and that of rabbits, both caused by bacilli. The bacilli of septicæmia in mice are extremely fine rods, similar to the bacilli of swine-plague (Schweinerothlauf). The bacillus of septicæmia in rabbits, described by Gaffky, is exactly identical with or closely allied to the bacteria of chicken-cholera, and to the bacteria which promote similar diseases in pigs, ducks, and deer (Schütz, Cornil, Kitt, Hueppe). Hueppe proposed for the latter bacteria the collective name of bacteria of hemorrhagic septicæmia. In these bacterial septicæmias, toxic products are, of course, also formed; thus Hoffa isolated, in the septicæmia of rabbits, a toxic base, methylguanidin ($C_2H_7N_3$), probably produced by the oxidation of creatin.

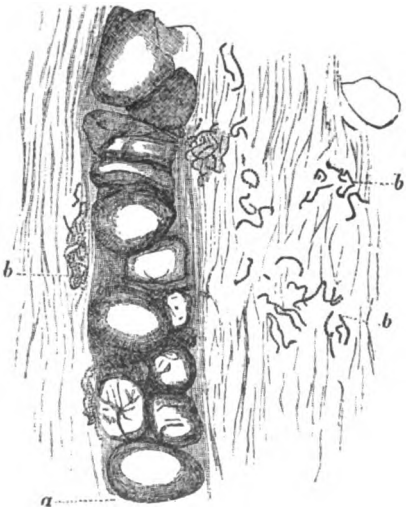
Fig. 1585.



Blood of a Septicæmic Mouse. Red blood-corpuscles and small bacilli.

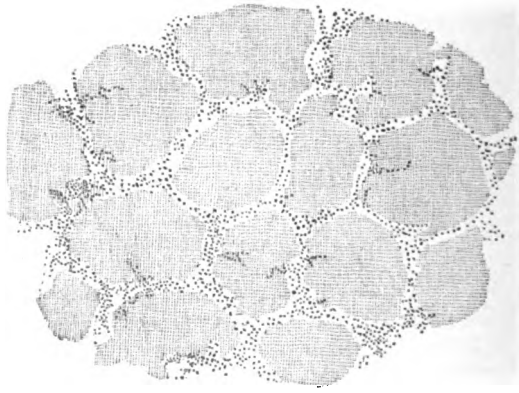
There is also a septicæmia produced by cocci in animals (Figs. 1586, 1587). One of these is the coccus of sputum septicæmia (A. Frankel), which can be caused in rabbits by injecting human saliva. The same coccus is very likely the promoter of croupous pneumonia in man. We

Fig. 1586.



Streptococcus of Progressive Gangrene in Mice. (After R. Koch.) *a*, Cells of the aural cartilage; *b*, streptococci. × 700.

Fig. 1587.



Streptococci between the Muscular Fibres. Colored with gentian violet after Gram's method. × 250.

may mention besides the streptococcus septicus (Flügge), also a coccus found by Nicolaier and Guarnieri in decaying earth, very similar to the streptococcus pyogenes; and finally the micrococcus tetragonus (Gaffky). Severe septicæmia is sometimes transferred to man by parrots. Lepetit found in such a case a small coccus, which he cultivated pure

from the blood. In the lung he found the staphylococcus aureus and citreus.

Hauser has given us reports of the morphological and biological behavior of three bacteria of putrefaction, called by him proteus vulgaris, p. mirabilis, and p. Zenkeri. From small rods, similar to the bacterium termo (Cohn), longer rods, good-sized threads, and spiral forms are developed upon a proper medium, and upon exhausting the latter, fall apart in short rods and forms like cocci, which are probably spores. These three bacteria of putrefaction, isolated from putrid substances, always produced putrid decomposition, while the filtrate without the bacterium had no decomposing (saprogenous) effects. Experiments upon the pathogenous qualities of the above-mentioned bacteria, and their relation to septicæmia, led to the conclusion that they produced a virulent chemical poison, very small quantities of which, introduced into the vascular and lymphatic systems, were able to kill small animals with the symptoms of putrid intoxication. The above-mentioned saprophytic bacteria are not pathogenous, that is, are not capable of growing within the living animal. Rosenbach also cultivated three saprogenous bacilli in pure cultivations, two of them having strong toxic qualities.

Experiments of Semmer, M. J. Rossbach, and Rosenberger, have shown that the injection of ferments, as, for instance, of papayotin or of sterilized septic blood, produces fatal sepsis with development of bacteria in the blood of the animal. I have myself injected sterilized putrid urine with the same results. These experiments would seem to prove that the injection of such putrid substances changes the condition of the blood to such an extent that bacteria develop in it, which otherwise, under normal conditions, are not able to develop in either the blood or the tissues.

Von Bergmann and Angerer have made interesting communications concerning the relation of ferment intoxication to septicæmia. Al. Schmidt, A. Köhler, Edelberg, Birk, and others had always observed the same symptoms during life and after death, from transfusing a blood over-rich in ferment, or from injecting fibrinous ferment into the vascular system of animals, as those caused by injecting putrid liquids, or such as had been rendered turbid by bacterial vegetation. The disturbances thus caused consisted principally in the dissolution of large quantities of white blood-corpuscles with secondary excretion of fibrin in the capillaries, in the large pulmonary vessels, and in the heart. Von Bergmann and Angerer produced the same disturbances by injection of large doses of sterile, clear solutions of pepsin and pancreatin. The severe ferment intoxications rapidly lead to death, with symptoms of putrid intoxication. The effects of pure ferments are thus similar to those produced by the pathogenous bacteria, that is, they destroy the white blood-corpuscles. Von Bergmann and Angerer were not able to confirm the reports of Rosenberger and Rossbach, that bacteria developed in the blood under the influence of sterilized solutions of ferments.

The frequency of septicæmia in man has been very greatly diminished since the knowledge of the etiology of this and like diseases has enabled us in most cases to avoid it. The fact is, that in large, well-conducted hospitals, we now very rarely have an opportunity to study the symptoms of this highly interesting affection. And we must always remem-

ber that, wherever sepsis occurs in operative cases, in which no wound existed before, a grave mistake must have been made by the operator. We are all aware how immensely the responsibility of the surgeon has been increased by this knowledge. It is unnecessary to mention how manifold the sources of infection may be during an operation, on hands, instruments, dressings, etc.

On the other hand, there still remain quite a number of cases, where the poison, entering through an apparently insignificant lesion, produces its deleterious effect with such tremendous rapidity that even our modern ways of disinfecting and treating wounds, etc., leave us at an entire loss how to save the patient. I remember a case where a child who had injured himself slightly by falling in the gutter in front of a butcher's shop, died within twenty-four hours of acute sepsis, in spite of thorough disinfection of the wound half an hour after the injury, long and deep incisions where the slightest swelling appeared, etc. In another instance, a butcher, having scratched himself with a piece of bone, died within thirty hours of septicæmia, in spite of most energetic and heroic treatment, long incisions, amputation of the arm, etc. The difficulty is that we cannot foresee the intensity of the infection which has taken place, and that experience teaches us that most of these cases recover under ordinary surgical treatment, in spite of the occurrence of acute lymphangeitis, with a temperature rising perhaps to 105° F., the patients usually recovering within twenty-four hours without recourse being had to any specially heroic treatment, which would, perhaps, be of no avail in those cases where it seemed really necessary.

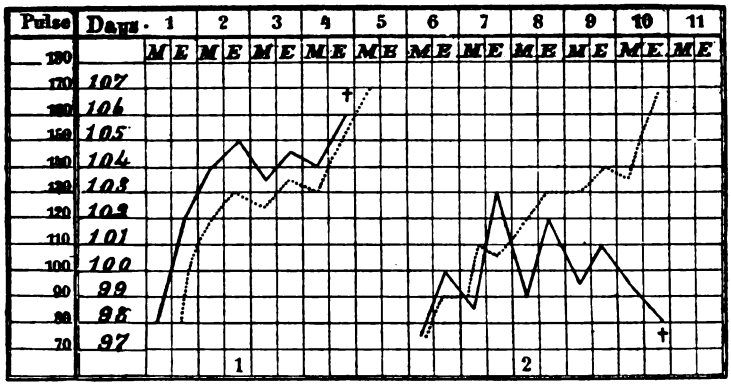
Morbid Anatomy.—The anatomico-pathological changes in septicæmia are, first of all, to be seen locally at the place of infection, at the wound and its surroundings, as will be described more minutely in connection with the symptomatology. The most constant changes are found in the blood of septic corpses; it is usually dark, of tarry consistence, incompletely coagulated, and subject to rapid decomposition, which accounts for the unusually rapid decay of such cadavers, so that after twelve hours sometimes not only internal organs, but also the outer surface of the body, may be in full decomposition. The blood has a special, sweetish, putrid smell, and quite often an acid reaction, which is caused very likely, as Vogel and Scherer have shown, by the formation of carbonic acid. There are always a large number of bacteria to be found in the blood and the different organs—a larger amount than in the cadavers of those dead from other infectious diseases. The dissolution of the leucocytes and to a certain extent of the red blood-corpuscles is characteristic.

The organs show few typical changes. What we find most often are small ecchymoses in nearly all of them. Heart and lungs show nothing special; sometimes we find diffuse pleurisy and symptoms of slight pericarditis. The intestinal tract frequently shows an extensive enteritis, sometimes a dysenteric inflammation. The spleen is constantly enlarged, hemorrhagic, and soft. Von Bergmann saw in forty out of one hundred and eighty autopsies, hemorrhagic infarcts of the size of a hazelnut in the spleen, which in his opinion were not caused by embolic processes. The liver is usually somewhat swollen, congested, and frangible. The kidneys always show marked hyperæmia. On the

surface of the kidney we find disseminated under the capsule minute foci of a yellowish color, which are surrounded by a tolerably sharply circumscribed zone of hyperæmia, and which represent the changes undergone by the glomeruli of the cortical substance. Manifold microscopical examinations by Ebert, von Recklinghausen, and a great many others, have shown that the cause of these changes in septicæmia, as well as in diphtheria and erysipelas, must be sought in the presence of multitudes of colonies of micrococci in the capillaries of the glomeruli, and in the vessels of the cortical substance. We must further note, that pregnancies are ended by abortion during septicæmia with absolute regularity, and we find, therefore, corresponding changes in the genital apparatus.

SYMPTOMATOLOGY.—The clinical course and symptoms of septicæmia are characterized by a high, usually continuous fever, and a series of typical inflammatory processes. But it must be added that there are septicæmias where high temperatures do not occur, or at least are inconstant, and give way to normal and sub-normal temperatures, while very high frequency of the pulse seems to be constant (see Fig. 1588).

Fig. 1588.



No. 1.—Fever-curve of Septicæmia, with high fever, death at 106° with pulse 170, the third day after operation (laparotomy). No. 2.—Fever-curve of Septicæmia with slight fever; death the fourth day after injury (gunshot wound) with subnormal, sinking temperature and rapid pulse.

The wounds from which septicæmia starts are sometimes fresh ones, sometimes granulating. Formerly, the idea of Billroth was accepted, that healthy granulations were impermeable to putrid fluids, but this proved to be not true, as Maas and Hack have shown, and as coincides with clinical experience. The local symptoms are very variable, and there are cases, as already mentioned, where the general intoxication takes place with such rapidity that no important local symptoms can occur. These are, however, exceptional cases.

Usually, the cases with distinct progressive inflammation starting from the infected spot show a decidedly less favorable prognosis than others. The usual course of those septicæmias which start from small lesions, as, for instance, of the finger, is as follows: from twelve to twenty-four hours after the injury, a chill sets in, with a temperature rising to 104° F., or more; the small wound is painful and inflamed; the glands of the elbow and axilla begin to swell; and the arm shows

red stripes on the flexor side (septic lymphangeitis). The next day the septic infection, under proper treatment, may be over, or recovery may ensue with formation of pus at the place of injury, or with circumscribed abscesses in the affected glands; or death may occur in consequence of septic poisoning. In other cases, the progressive inflammation is more intense, and leads to the formation of vast phlegmonous processes, with high temperature. In a certain series of cases, especially after extensive injuries, caused, for instance, by being run over, an acute, rapidly progressing putrid inflammation sets in, with formation of gas, and usually ends fatally within forty-eight hours. In other cases, again, the dependence of gangrene upon the wound, as in the former cases, may be excluded, and nevertheless gangrene and putrefaction, with formation of gas, occur quickly, much in the same manner as is sometimes observed after snake-bite. In this group belong those cases described by Pirogoff as acute purulent œdema, and by Maisonneuve as *gangrène foudroyante.*

The other symptoms referable to the internal organs are caused by the general septic infection. Usually the spleen and very often the liver are distinctly enlarged, and rarely we find jaundice, which is of hæmatogenous nature, caused by destruction of the red blood-corpuscles by the micro-organisms or their products. Gastro-enteritic symptoms are nearly constant; in severe cases the patient has diarrhœa, with stools of sometimes feculent, sometimes mucous, watery, or even hemorrhagic or diphtheritic quality. The urine contains albumin. Sometimes diffuse pleurisy, or inflammation of the pericardium or endocardium, brings about further complications. The skin quite frequently shows exanthematous eruptions, in the shape of small blisters or pustules, or resembling urticaria, measles, or scarlatina. Besides, it may be mentioned that sometimes large vessels are eroded by purulent abscesses, thus occasionally leading to fatal hemorrhage.

DIAGNOSIS.—The diagnosis of a well-developed septicæmia, with the characteristic symptoms described above, cannot present any difficulties; but in some cases it may be very hard to recognize with certainty, in the very beginning of the disease, the outbreak of the septic general infection. This may be so especially in the cases of so-called cryptogenetic septicæmia, that is, when the point of entrance of the poison cannot be found. The two points upon which we must chiefly rely are the sudden and continuously high fever, and the quality of the pulse, which is small and very frequent.

PROGNOSIS.—The prognosis of septicæmia is in well-developed cases mostly fatal; it grows relatively better, as we can get at and remove the primary focus of infection by adequate treatment. After the source of infection is disposed of, the resorption of the bacterial toxic products comes to an end, and therefore, also, the putrid intoxication. Of course, the prognosis will be influenced considerably by the physical condition and power of resistance of the patient. Then we must not forget that very often the prognosis as to the local condition is not identical with the general prognosis. Extensive gangrene, for instance, may develop irresistibly while the general intoxication does not increase, so that the patient may have time to overcome the infection;

while, on the other hand, cases with only slight local reaction, or none at all, may end fatally within a short time as a result of the general intoxication.

I must not omit a certain form of septicæmia, which it is important to be familiar with, in forming a prognosis. This is the so-called recurrent septicæmia, or tardy septic suppuration, where all the symptoms disappear, and the disease apparently comes to an end, but where after weeks, months, and sometimes years, an acute general intoxication starts from the old place of infection, and may then prove fatal.

As these cases are rather rare and interesting, I may briefly quote one under the care of Prof. Karl Gussenbauer, of Prague:—

A healthy official, 36 years of age, had received two gun-shot wounds in his right instep in 1866. One of the bullets was extracted two weeks afterwards from the neighborhood of the external malleolus. The foot continued to suppurate for two years, and only healed after necrosed pieces of bone had been repeatedly extracted. The sinuses closed in 1868. The man remained cured and healthy till the year 1877, when a sinus opened, and healed again after a short time, after expelling a small sequestrum. On the 18th of February, 1882, he was brought into the Clinic with symptoms of pyo-septhæmia. A week before, he had suddenly felt severe pains in the right foot, after a somewhat fatiguing walk. The whole foot soon became very much swollen, and a chill set in, followed by very violent fever. On the fifth day a sinus opened spontaneously, and offensive pus was evacuated. But this time the phlegmonous inflammation of the surrounding part did not subside upon the evacuation of the pus; the high fever also continued. The day before he came to the Clinic, the phlegmon had rapidly progressed, till it covered the whole dorsal surface of the foot; another chill ensued, and the patient felt very weak. On his entrance, he was found to have a very considerable diffuse œdema of the entire right foot, the skin of a dusky red, partly purplish hue, and gangrenous around two suppurating openings over the second and third metatarsal bones. The patient showed the clinical picture of a severe septhæmia. He was received late in the evening. When seen the next day his case seemed to be already hopeless. Pulse 120, temperature 40.4° C. (104 $\frac{2}{5}$° F.). Amputation of the lower leg was proposed to the patient, but he refused; thereupon multiple incisions were made, with energetic disinfection. These showed that there was extensive destruction in the subcutaneous and subfascial tissues, and necrotic bone, so that complete removal of the gangrenous portions seemed impossible without amputation.

This treatment seemed to cause a remission of the fever—(the temperature sank from 40.4° C. (104$\frac{3}{5}$° F.) in the morning to 38.4° C. (101° F.) in the evening—but was not able to stop the progress of the septic phlegmon. The very next day, March 2, the patient again had an evening temperature of 40° C. (104° F.), which rose next morning to 40.2° C. (104$\frac{1}{5}$° F.) Meanwhile the symptoms of septic phlegmon with phlebitis had appeared in the lower leg. Another chill occurred; the patient, when left alone, lay in a sopor. Amputation was again recommended, and this time the patient gave his consent. Amputation of the thigh was now necessary, and the limb was removed above the condyles of the femur. In the evening the temperature had sunk to 37.6° C. (99$\frac{1}{2}$° F.) and the patient was in good spirits. Next morning, however, it had again risen to 40.2° C. (104$\frac{1}{5}$° F.) after the patient had had another chill during the night, and in the evening of the fifth day death ensued with a still higher temperature and in deep sopor. At the autopsy multiple purulent foci of softening were found in the lungs, swelling of the spleen, and colonies of micrococci in the cortices of the kidneys. Examination of the foot showed a large, irregularly-shaped fragment of a leaden bullet in a cavity filled with pus, and with bony walls formed from the bases of the second and third metatarsals.

TREATMENT.—The treatment of septicæmia is naturally local, as well as general; the former consists essentially in an adequate surgical treatment of the existing wound. Like any other wound-complication, septicæmia will be avoided with certainty by a thorough and careful antisepsis and asepsis. But also wounds complicated by infection of a malign character usually heal without much difficulty if only the infection is at once recognized as such, and correspondingly treated. This is clearly shown by the prompt healing of the manifold wounds of surgeons, anatomists, etc., which are infected sometimes by pus or putrid substances of the most malignant description. The special treatment of these wounds follows so closely the generally acknowledged rules of surgery, that it is hardly necessary to mention them in detail. It may suffice to say that immediate enlargement of the wound, unless superficial, by an incision; thorough washing with bichloride solution, 1 to 1000, or five-per-cent. carbolic-acid solution, or ten-per-cent. chloride of zinc; and the use of a bandage wet with a two-per-cent. carbolic-acid solution, usually do the work promptly. I may lay special stress upon the moist dressing, which, frequent as was its use formerly, seems to have been too much abandoned lately by the general practitioner. We need not be surprised to see retention take place, when infected wounds are powdered thickly with iodoform, and covered with cotton, laid immediately upon it. The moist dressing mentioned above, kept from drying either by rubber tissue or, as some prefer, by wetting it at certain intervals, not only apparently counteracts the infection by saturating the tissues with antiseptic fluid, but also has the great advantage of reducing pain in a marked degree. This latter symptom must be watched very carefully, as it is really of the highest importance. If pain disappears under the treatment, we may be sure that we have overcome the infection, while the persistence of pain demands further attention.

The treatment of septic phlegmons and gangrene follows closely the generally acknowledged rules of surgery. Often enough, we have to try to save the patient's life by high amputation, or by exarticulation, the latter being sometimes preferred, because a shorter operation than the former, and because it is well to expose septic patients to as little shock as possible. Of course, a secondary amputation may then be postponed until the patient has somewhat recovered. Shock must be avoided as much as possible with all septic patients, since they bear it very badly, and are extremely sensitive to it. Very often, therefore, a short administration of chloroform or bromethyl—it takes very little to anæsthetize them—must be resorted to during a change of dressing, if it is expected to be very painful. The lowering of vitality by the anæsthesia is usually less detrimental than the depression produced by pain. Apathy and analgesia are, according to my experience, among the worst prognostic symptoms. It is very difficult to decide upon the proper time for amputation. Free incisions and efficient drainage will be sufficient in a great many cases, while in others only early and high amputation will save the patient's life. This question cannot be decided by the local prognosis alone, but the general condition of the patient must also be taken into consideration.

Besides the local treatment, which is surely the most important part for the surgeon, we have no means of treating septicæmia as such, and are, therefore, restricted to treating the symptoms separately. As the

usual continuous and high fever is one of the principal features of this disease, it is only natural that a great many physicians should have paid special attention to the relief of this symptom. They have thought to achieve good results and to influence the disease itself when they have attacked and succeeded in overcoming this most threatening and striking feature. But what has been said in regard to high fever and its treatment in erysipelas, holds good in septicæmia as well. First of all, we deprive ourselves of one of the most trustworthy indicators of the status of the disease, by lowering the temperature. Since the teaching of Bärensprung-Liebermeister, that temperatures beyond $105\frac{3}{5}°$ could not be survived by man, has been proved incorrect by Unverricht, Kürschmann, Eichhorst, Naunyn, Heubner, von Jacksch, Fränzel, Strümpell, and others, we have learned that the lowering of high temperature is not the most important element in the treatment of fever. Besides the first point mentioned above, it is more than probable that the conception prevalent among Volkmann's disciples is correct, that the high temperature produced by septic infection is a reaction of the system which effects a sort of self-protection, most bacilli being unable to bear any markedly increased heat. In fact, the correctness of this opinion has been experimentally proved beyond doubt by K. Wagner.[1] He showed that animals injected with the poison of anthrax, and prevented from getting fever by hanging their lower extremities in water at 77° F., all died, while other animals kept for control and injected with the same dose, not being prevented from having high temperatures, $4\frac{1}{2}°$ and more above normal, all survived. Of a large number of other animals injected with antipyrine as an antipyretic, one half died. Besides all this, artificial lowering of the temperature is attended by another great danger, viz., collapse.

The principal point in treating fever seems to be much more to support the action of the heart, which has to accomplish nearly double its normal work. This is best achieved, in spite of all that has been said against it, especially by English and some American authors, by the administration of large doses of alcohol, in any of its different forms. Compare what has been said upon this subject in describing the treatment of erysipelas.

Billroth has advised the encouragement of diaphoresis in septic patients by using well-known medicaments, and specially by warm baths of one hour's duration. Since Brunner and others have discovered the staphylococcus pyogenes in the sweat of animals and men infected with this specific micro-organism, the correctness and practical value of this practice are established beyond doubt.

Septic diarrhœa must be treated by opiates, tannin, subnitrate of bismuth, acetate of lead, enemas of starch with tannin, opium, etc. Unfortunately we often meet with small success from these remedies, especially if the movements occur as often as every fifteen or thirty minutes, when they will be mucous, watery, and often bloody. If collapse sets in, injections of ether and musk must be given, but can, of course, be only of temporary value.

Special attention must be paid to the avoidance and, if they occur, to the treatment of bed-sores. There is hardly any other disease where bed-sores develop so easily and to such an extent. A septic patient

[1] Of the Importance of Temperature in Infectious Diseases. (Vrach, 1890, Nos. 39–40.)

should, therefore, always be put immediately on a water-bed, if possible on one with a central opening, which allows of defecation without the patient being disturbed; the water-bed rests on a stretcher with a corresponding opening, and the mattress under it is divided into three parts, so that the middle one may be removed for defecation (Volkmann's Heberahmen). If such an apparatus is not available, we must substitute water-pads or rings, or other cushions. But we must always bear in mind that it is a grave mistake, committed very often, to pad the spot where we wish to avoid sloughing. The place where we most expect it must be left bare, and the surrounding parts well padded. Cotton is probably the worst padding material, as it crumples and forms hard lumps. The treatment of existing bed-sores is that usually adopted.

If the patient is convalescent, a roborescent treatment, including the use of tonics, has its full value. A long sojourn in the mountains, or in a watering-place not near the sea, often proves beneficial.

Pyæmia.

Pyæmia was, until very recently, supposed to be an intoxication by means of pus, caused, as its name implies, by intrusion of the components of pus into the blood (πῦον, "pus," and αἷμα, "blood"). In the correct modern etiological definition of pyæmia, it hardly figures as a disease *per se*, since it is caused by the same micro-organisms as septicæmia. The principal anatomical and clinical difference in pyæmia is the development of multiple suppurative foci (metastases) in the various organs, consequent upon the transportation of the pyæmic poison, and secondly, the intermittent character of the fever. But, as mentioned in speaking of septicæmia, a strict discrimination between that condition and pyæmia is very often even clinically and anatomically impossible; and it is, therefore, easy to understand that many authors on the subject have totally given up all attempts at differentiation. The same micro-organisms cause both affections, and it is of little importance if the infection leads to suppuration. It is really only a concession to custom, to describe septicæmia and pyæmia separately, instead of including both under the heading, pyo-septicæmia or septico-pyæmia.

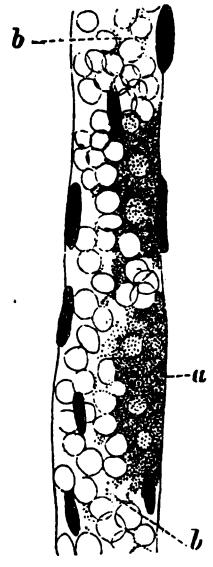
Etiology.—Robert Koch has produced experimentally pyæmia in rabbits, in analogy to the septicæmia of mice mentioned on page 94. It is caused by a specific coccus, different from all others. Gussenbauer believed that he had found in the same way a specific micro-organism for pyæmia in man, but this has proved to be an error. Generally we find the same kinds of micro-organisms as in septicæmia (see p. 93), which proves that it is impossible, as mentioned above, to keep these two diseases etiologically apart.

Pyæmia may be caused either by cocci or by bacilli, the former being specially the common cocci of suppuration. Any acute abscess can lead to pyæmia, and it is really hard to explain why only in some exceptional cases pyæmia does actually result, if we do not assume that in most cases of acute abscess the system of the individual is protected from a generalization of the process by an inflammatory infiltration surrounding the focus. I do not believe, as a great many do, that the

accumulation of small round-cells at the confines of the abscess-cavity mechanically prevents the proliferation of the cocci, or that these cells destroy the bacteria by acting as phagocytes; but I rather think that the fluid surrounding these cells exerts a deleterious effect on the micro-organisms. The recent investigations and the results of blood-serum therapy in other bacterial diseases, such as tetanus and diphtheria, point strongly to the opinion that the blood, or rather the blood-serum, has a bactericidal power which usually prevents the generalization of the process. But if this quality should happen to be impaired, the infection may spread, as no barrier intervenes.

MORBID ANATOMY.—Clinically there are two forms of pyæmia. One is characterized by the existence of a single large focus of suppuration, as, for instance, a suppurating joint, or a compound fracture in a septic condition, whence constant invasion of masses of micro-organisms takes place, producing fever which leads to death. In the other variety, there is no such central focus of suppuration, a slight wound only having been received, which may be entirely healed when general pyæmic infection sets in, and perhaps proves fatal. A great many cases of this kind figure as cases of cryptogenetic pyæmia. Other so-called cryptogenetic cases find their explanation at the post-mortem table in an unsuspected abscess somewhere in the organism, from which the general infection had started.

Fig. 1589.



Blood-vessel from the Cortical Substance of the Kidney of a Pyæmic Rabbit. *a*, Micrococci, enclosing blood-corpuscles, crowded against the walls; *b*, small group of cocci between blood-corpuscles. × 700. (R. Koch.)

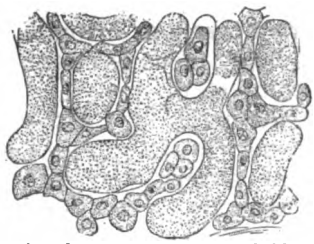
The frequency of pyæmia has been lessened to a vast degree in modern surgery. In earlier times, many hospitals were infamous for the frequent occurrence of pyæmia and allied conditions in their wards. I must repeat here the well-known fact that typical antisepsis and asepsis, thoroughly carried out, are absolute prophylactics against such infection.

The anatomical changes which take place in pyæmia are briefly these: While in septicæmia severe poisoning of the whole organism prevails, pyæmia is characterized by local inflammatory processes. We find micrococci in the blood-vessels, in the blood (in the plasma as well as especially in the leucocytes), and in the different organs and metastatic foci (see Figs. 1589, 1590). Of special interest in pyæmia are the bacterial inflammations of the walls of the veins, with consecutive formation of thrombi which are subject to suppurative decay under the influence of the invading cocci (Fig. 1591). These conditions explain the formation of metastatic abscesses: particles of these suppurated thrombi are torn off and carried away by the current of the blood, and lodge anywhere as emboli, as, for example, in the capillaries of the lung, reproducing everywhere thrombosis and suppuration. These metastases and foci of micrococci may occur in almost every organ, in the muscles of the heart, in the pericardium and endocardium, in the lungs or pleura, in the brain, liver, spleen, or kidneys, in the joints, in the marrow of bone, in the muscles, lymphatic glands, or skin. When the

latter is involved, we sometimes find erysipelatous reddening, which usually disappears after a few days, and also small blisters and pustules.

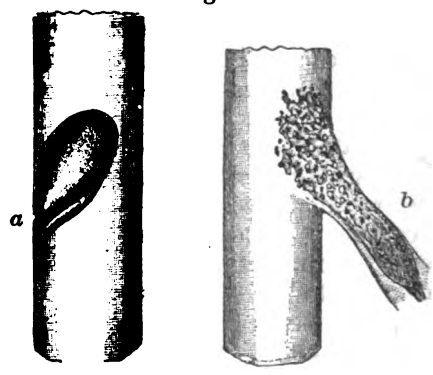
SYMPTOMATOLOGY.—The clinical course of pyæmia is characterized by the symptoms produced by the development of multiple metastatic abscesses, and by an intermittent fever, with intercurrent chills (Fig. 1592). The atypical curve of fever is typical for pyæmia; its intermit-

Fig. 1590.



Preparation from the Liver of a Soldier Dead with Pyæmia. The capillaries between the cells of the liver are filled with masses of micrococci. (Klebs.)

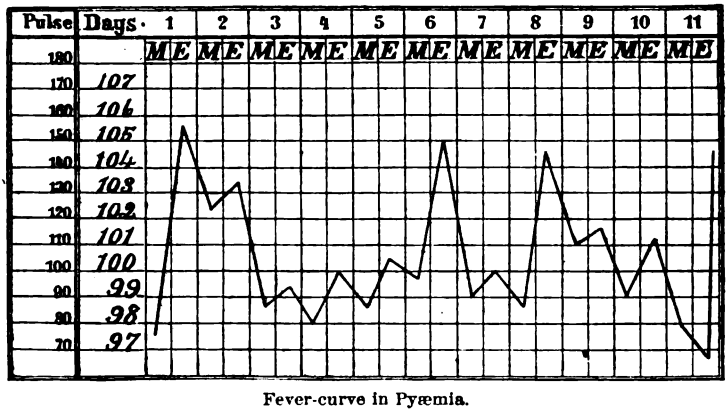
Fig. 1591.



a, Thrombus attached to a valve of a vein; *b*, suppurative thrombus of a vein.

tent character is irregular; that is, after high temperatures, we suddenly observe normal or sub-normal temperatures of variable duration. The beginning of pyæmia is usually accompanied by a severe chill, which may be repeated irregularly with more or less frequency, and has an inconstant duration; after each chill the temperature rises more or less quickly up to 104° F., or more, and may fall again just as quickly to the normal. This irregular course of the fever may be explained by the absorption into the system of micrococci and their poisonous prod-

Fig. 1592.



Fever-curve in Pyæmia.

ucts, from some focus of suppuration, which having been overcome, a normal temperature follows. The rapidity of the pulse follows the temperature more or less closely, with the exception that it always shows an inclination to stay rather frequent, even in the intervals of the fever. The general condition of the patient is typical of high fever, all the so-called typhoid symptoms being present, as they have been

described in septicæmia, such as headache, nausea, vomiting, diarrhœa, albumin in the urine, and sometimes hæmatogenous jaundice.

The other symptoms are produced mostly by metastatic processes in the inner organs, the lungs, liver, spleen and kidneys. Hæmoptysis, lobular pneumonia, abscesses in the lungs, and the different forms of pleuritis are quite frequent. Next in frequency are abscesses in the spleen and metastatic suppurations of the joints, while abscesses in the liver and kidneys are comparatively rare. In judging of the significance of brain symptoms in high fever, we must bear in mind the fact that a considerable number of cases are complicated by metastatic abscesses in the brain. The metastases in the superficial organs, such as the lymphatic glands, parotids, joints, muscles, and subcutaneous cellular tissue, are relatively easy to recognize, if we look for them carefully. This is necessary, because a great many of these abscesses originate and develop without the slightest pain, or without localized pain, and thus may be overlooked. Attention is called to them, however, by the sudden occurrence of fever, which indicates the existence of a new focus of suppuration.

As intercurrent symptoms, we have to mention, finally, secondary hemorrhages, which are caused by the decay of thrombi in arteries as well as veins, after they become infected. These are the usual secondary hemorrhages; but there is also another kind, which occurs if the walls of the blood-vessels become corroded in phlebitis. The bleeding is mostly of a venous character, but arterial hemorrhages have also been observed not very rarely, especially if branches of arteries have been cut and ligatured near a main trunk.

According to the duration of pyæmia, we distinguish an acute and a chronic form, the acute variety lasting from eight to ten or twelve days; then there is a so-called sub-acute form, lasting three or four weeks, and finally, but rarely, the true chronic form, lasting from two to five months. Sometimes, the course of the disease seems to be run, when suddenly, after months, septic material is set free from a focus hitherto encapsulated, causing again a general infection, to which the patient may succumb.

DIAGNOSIS.—The diagnosis of pyæmia, with symptoms as described above, cannot be attended by any real difficulty; at least, we may readily recognize a septic infection, the specific character of which is practically of no real importance, as the treatment will be essentially that of sepsis generally.

PROGNOSIS.—The prognosis of acute pyæmia is almost without exception absolutely fatal. The course is more rapid in proportion to the quicker succession of chills and fever attacks combined. Cases of a more chronic form end in exhaustion. Some cases, especially if the abscesses have been accessible to surgical treatment, have been cured in spite of multiple metastases, and even some cases with abscesses in the vital organs, and yet without fatal result, have been observed.

TREATMENT.—The treatment of pyæmia approaches very nearly to that of septicæmia, and I therefore refer to what has already been said, with the only difference that in pyæmia the local treatment is of even higher importance, as we are sometimes able, at least in the beginning,

to eliminate the source of infection by attacking the primary focus, if this is within reach of the knife. Much more important than the treatment is the prophylaxis of pyæmia, for it can be avoided with certainty, as I have repeatedly declared.

III. Hospital Gangrene.

A short sketch of hospital gangrene (gangræna nosocomialis) may be of some interest, though mostly historical, since it has practically disappeared from the list of diseases known in civilized countries. Only in war-times might we see it again, if the general effort to invent a simple but effective method of dressing and treating wounds on the field of battle should fail to fulfil what it promises.

Hospital gangrene is a wound-infection of local character and undoubted bacterial origin, consisting in gangrenous decay of the granulations of a wound and its surrounding tissue. Its specific microorganism has not thus far been ascertained. The question of the identity of hospital gangrene with diphtheria has been widely discussed, and seems to be decided in the negative.

The nature of hospital gangrene in a pathological and anatomical sense may be defined as necrotic coagulation (Coagulations-nekrose of Cohnheim and Weigert), with masses of micrococci and bacteria of putrefaction.

Hospital gangrene has occurred mostly, as the name indicates, though not at all exclusively, in hospitals where many patients with suppurating wounds have been crowded together, and has appeared as an epidemic, sporadic cases being unusual. It is decidedly contagious, its transferability being experimentally proved by O. Weber.

Clinically we discriminate three distinct forms, the superficial croupous and diphtheritic form, the diphtheritic ulcerous, and the pulpy form, the latter being the most malignant. There are of course many transitional forms, which make it impossible to distinguish strictly the different kinds. They vary in their symptoms from the formation of a diphtheritic membrane, with slight swelling and consecutive decay, to rapid turgescence of the tissues caused by extensive hemorrhages into the granulations, with putrid decomposition of the whole mass, and generation of gases. The turgid gray or reddish-gray wound looks, as König says very aptly, like a putrid, softened spleen or brain.

The *course* of the disease depends entirely upon the depth to which the gangrene penetrates, and upon when the process comes to a stop. The rapidity with which the gangrene spreads is very variable, the wound in some cases increasing to more than double its size within twenty-four hours, while in other cases the disease progresses slowly.

The general *symptoms* correspond exactly to the intensity of the local process, and show the true characteristics of septic fever.

The *prognosis* depends entirely upon the form of the gangrene, and upon the remedies adopted. *Treatment* is by no means a thankless task; the energetic application of the thermo-cautery of Paquelin, or of caustic chemicals, especially bromine, nitric acid, or chloride of zinc, will be effectual in limiting the gangrene. In a few cases amputation may be required. Out of consideration for other patients, every case of hospital gangrene should be strictly isolated.

GUNSHOT WOUNDS.

BY

P. S. CONNER, M.D.,

PROFESSOR OF SURGERY IN THE MEDICAL COLLEGE OF OHIO, SURGEON TO THE CINCINNATI AND GOOD SAMARITAN HOSPITALS, ETC.

REVISION of any article on gunshot wounds written a dozen or more years ago becomes necessary because: (1) Of the changes that have been made in the military armament; (2) of the determination of the bacterial origin of each of the complicating diseases, erysipelas, septic infection, and tetanus; (3) of the general adoption of antiseptic and aseptic methods of operating and dressing; and (4) of the more active and in no small measure successful treatment of lesions of the head and abdomen, now commonly employed.

BULLETS.

To the army of each of the civilized nations there is now issued as the standard rifle a weapon of small calibre; and the powder in use is much stronger than that formerly employed. The service bullet has a diameter of about .30 of an inch, instead of .45, .50, or .55, as before, and is both relatively and actually longer; its weight, however, is much less. Made of hardened lead, it is jacketed with a thin envelope of steel, of nickel, of copper, or of an alloy of these metals with or without zinc addition. As a result it does not undergo deformation in the body, or only to a slight extent, and that chiefly in flattening of its apex. It very seldom breaks up, though occasionally the jacket has been found to split or to strip off in part or in whole, least when of steel, most when of copper.

The annexed table shows the weight, size, initial velocity, etc., of the various bullets employed in modern warfare.

Driven by one or other of the recently invented explosives of high grade, and rotating more frequently because of the altered rifling of the gun, this new bullet has a much greater initial velocity, its trajectory is flat, and its range is greatly increased. Its momentum is such that lodgment in the body will not take place except at an extreme distance, or after having passed through several other bodies. Its rotatory steadiness in the middle ranges, that is, from 500 to 1500 or 2000 yards, together with its preservation of form, causes it to pass through the tissues without damaging the parts around to anything like the same extent as did the old bullet. Up to 500 yards, or some-

what less, in the so-called "zone of explosive effect," the cross section of the area of damage differs but little from that formerly observed; and the same is probably true of wounds received very far from the firing party. At the two extremes of range the bullet oscillates considerably; just as, as has been said, the spinning top "wabbles" in the beginning and at the end of its turning.

Country.	Type of Weapon.	Calibre in Inches.	Weight of Bullet in Grains.	Weight of Charge (smokeless) in Grains.	Bullet Covering.	Muzzle Velocity in Feet.
Austria	Mannlicher	.315	215	40	Steel	1968
Belgium	Mauser	.301	216	43	German silver	1980
Denmark	Krag-Jorgensen	.315	235	76(black)	Copper.	
England	Lee-Speed	.303	215	66 "	Nickel and copper	2000
France	Lebel	.315	216	42	Maillechort (alloy of copper, nickel, and zinc).	2073
"	Berthier	.301	205	33	Maillechort	2971
Germany	Mannlicher	.311	225	38	Steel (plated with alloy of copper and nickel).	2034
Italy	Carcano	.256	231	34	Maillechort	2329
Japan	Murata	.315	238	36	Copper.	
Portugal	Kropatschek	.315	245	70(black)	Copper.	
Russia	Mouzin	.300	215	33	Maillechort	2000
Spain	Mauser	.295				
Switzerland	Schmidt	.295	216	31	Copper or steel.	
United States (new)	Krag-Jorgensen	.300	220	36	German silver	2000
" " (old)	Springfield	.450	500	70		1300

Observation of a limited number of injuries received in actual warfare and the study[1] of many experimental wounds (by none more thoroughly and satisfactorily pursued than by Assistant Surgeon La Garde, U. S. A.) have shown that the injuries that are to come under notice in future wars will in some particulars be quite unlike those met with during the first three-quarters of the century. Neither the ball itself nor pieces of it may be expected to lodge, and, therefore, there will be few or no extractions to be made, except of foreign bodies accidentally carried in. Whether or not pieces of clothing will ordinarily lodge or be carried out by the perforating shot, remains to be seen; they certainly will be of smaller size than those torn off by the old bullet, and probably will be much less frequently detached. Proportionately less septic infection of the wounds may, therefore, be looked for, although the investigations of La Garde and Messner have shown that even if no foreign body other than the bullet enters, there may yet be septic organisms introduced upon it, the generally accepted opinion that sterilization must necessarily be produced in the firing not being correct. Von Beck has found that the bullet is much less heated than commonly supposed, the temperature of the recovered steel-jacketed, calibre .30 shot being but 78° C., and of the copper-jacketed shot 110° C. Deflection of the ball will probably not be observed.

In correspondence with the less size of the bullet the wounds of entrance and of exit are smaller than heretofore, the more so proportion-

[1] In this study many surgeons have been much occupied: among them Delorme, Chavasse, Chauvel, and Nimier of France; Bruns, Busch, and Reger of Germany; Morosow, Tauber, and Pawlow of Russia; Habart of Austria.

ately as the range is greater. No material difference in size commonly exists between these wounds, that of entrance being of about the diameter of the ball, and that of exit but little larger, except when there has been injury of bone; and even then much increase in size is by no means always observed. The entrance wound is commonly round, with edges clean cut or, more often, turned in; that of exit round, slit-like, or stellate, according to the elasticity of the skin and its attachment to the parts beneath.

The character of the lesion, be it of soft parts, of bone, or of viscus, depends largely upon whether or not the person wounded was within or without the "zone of explosive action," a zone extending about twice as far as formerly, that is, to from 350 to 500 yards. Within this distance the effects of the shot, though somewhat less serious perhaps, differ but little from those heretofore observed, the destruction in either case being at short range very great. In the longer range, there is much less damage done than by the old, large, soft-lead bullet. Especially is this true in the soft parts, in which the shot-canal is but little if any larger in cross section than the missile itself, and the devitalization of surrounding tissue is of much more limited extent. The ball passing through a muscle in the direction of its length may only separate the fibres, so that it may be difficult or even impossible to find its track.

It is probable that fatal primary hemorrhage will be less frequent, because of the smaller size of the bullet, though the greater velocity of the missile will make it much more unlikely that any vessel in its course can escape injury. The larger nerves are more endangered, for the same reason.

It is in the bones that the most marked differences in the character and extent of injury have been found to exist; in some measure within, but greatly more without the "explosive zone." Speaking generally, there is more boring and less smashing. In the middle distance, that is, between 500 and 2000 yards (and it is in this range that most of the wounds will occur), the bullet, striking the shaft of a long bone, as a rule gutters it or perforates it quite cleanly, producing few fissures, and consequently large fragments, which are generally but little displaced, and at times not at all so. Much of the periosteum may remain untorn, holding the fragments together. When it is an articular extremity that has been injured above or through the joint, there is even less comminution, the perforation is a clean one, and the wound of the bone is much like a seton wound of the soft parts. At close range, and at a remote distance (2000 yards or beyond), the amount of destruction is very much greater, and the injuries are not materially different from those observed in the wars of the past. At all distances the short and flat bones are less damaged than the long ones, and much less so than formerly. Visceral lesions, aside from those necessarily fatal, will in all probability be found to be decidedly less severe, certainly in the middle distance, the shot track being smaller, the damage to the surrounding tissue less, and the missile passing through and out. Whether or not in organs like the brain, liver, spleen, or kidney, hydraulic pressure is greater than before, is somewhat uncertain; but it probably is not, outside of the "explosive zone." At short range such pressure has at times been found to cause most extensive destruction, even when the shot has struck a well-filled hollow viscus.

As far as can be determined from consideration of the reports of the comparatively few cases that have been observed in the late conflicts in Chili, Venezuela, Cochin China, and South Africa, and from experiments made upon the cadaver, it would certainly seem that the prognosis in wounds made by the newly adopted bullet is decidedly more favorable than it was in injuries of like parts as formerly met with.

Wound Complications and Aseptic and Antiseptic Wound Treatment.

But a few years ago septic infection was the only wound complication recognized as due to the action of a definite and determined microorganism; now it is known that the same is true of erysipelas and tetanus. It is these complicating diseases that have been the bane of military surgery, and that have caused death in the great majority of fatal cases after gunshot injuries and operations, where it has not been consequent upon shock or early hemorrhage. The discovery of their mycotic origin, and the development of a method of dressing which more or less perfectly prevents or antagonizes the action of morbific germs, has greatly affected the treatment of gunshot wounds in civil life, and must do so, as far as it may be practicable to carry it out, in military service.

Removal of the Ball, etc.—Whenever the location of a lodged bullet can be readily determined, either by probing of the wound or palpation of the damaged part, the missile should be removed, provided that this can be safely done; but under other circumstances the ball should be left undisturbed, to become encapsulated or to make its way after a time to a place where it can be felt and extracted. One of the good things about the new bullet is that commonly it will not lodge, and will not therefore have to be regarded in the treatment of the wound which it causes. Protected by proper treatment against infection, early closure of the wound will usually take place, and this whether the lesion has been a penetrating or a perforating one. The danger of death from shock remains as heretofore, but that from hemorrhage, other than primary and excessive bleeding, is greatly less, since operations for the exposure and securing of the wounded vessels can be done with comparatively little risk. A gunshot wound in civil life to-day, unless from its very nature a mortal one, may be expected to be recovered from, if from first to last it is protected from infection from without; and the advances in aseptic and antiseptic treatment that have been made in these latter years have rendered it usually practicable to do this. Knowing as we now do that in the great majority of cases any complicating erysipelas, septicæmia, pyæmia, or tetanus is consequent upon organisms that have been introduced into the wound after and not at the time of the receipt of the injury, it is imperative for the surgeon to employ only surgically clean instruments—probe, finger, forceps—and to permit only sterilized dressings to come in contact with the wounded area. Far better is it that the extent of the injury and the position of the ball should remain

unascertained, than that exploration should be made with a finger or probe that carries upon it morbific germs. What hospital surgeon has not again and again seen pistol wounds that have been rendered dangerous, not to say fatal, by the idle curiosity or useless zeal of the practitioners who had first seen them? Once properly cleansed and dressed, the after-treatment is that of wounds in general. If possible to avoid it, no piece of clothing that may have been introduced should ever be left, for it is almost absolutely certain to be a carrier of infection, and whenever therefore there is a reasonable probability that a bit of cloth is in the wound, careful search for it should be made with the finger, the only instrument that is likely to detect its presence.

DRESSING OF THE WOUND.—How far it may be practicable in military practice to early protect a wound, is to be determined in some future great war. When regard is had to the condition of the soldier's clothing, the long time that he may have to lie upon the field before he can be removed, and his surroundings while in transport to hospital, one may reasonably doubt if his wound is likely to remain uninfected until it becomes possible to properly dress it. Military surgeons of wide experience have advised the issuing of antiseptic packets for primary use, but it may well be questioned if they will prove of much value.

While the modern wound treatment has rendered practicable many an operation that in years gone by could not properly have been undertaken, it has even more permitted of a conservatism that at an earlier date would have been at the expense of life. In no other class of injuries probably is this more true than in gunshot wounds. Lesions of bones and joints produced by pistol balls rarely demand amputation or excision. Careful cleansing, proper drainage, aseptic dressing, with immobilization, will in the great majority of cases enable the surgeon to save the part, and not seldom to preserve in large measure its functional value. The new bullets, at other than close range, boring through the bones and causing little splintering or separation of fragments, will make wounds which, if protected from infection, may be expected to heal promptly, and to be followed by but a minor degree of late disability. If very destructive action is produced by these long bolts of small diameter, it will most likely be observed in cases occuring in civil rather than in military life, in street firing and mob fighting, and in wounds inflicted at short range, when, as has been already said, the damage done by the new is about the same as that caused by the old bullet, "always enormous." Never have I seen, in men brought from the battle-field, bullet-wounds of such terrific character as those observed in the Cincinnati Hospital during the riot of 1884, in patients who had been struck by the Springfield rifle bullet, calibre .45, at very close range, from 50 to 250 feet.

WOUNDS OF THE HEAD.

With the adoption of antiseptic methods of treating wounds in general, has come a marked change in the management of penetrating wounds of the skull. No longer left to themselves, to terminate very

generally in death, every effort is made to protect them against septic inflammation, and, as far as may be possible, to remove irritating foreign bodies, and by drainage to lessen intracranial pressure.

The high mortality rate of these lesions is due to shock, to hemorrhage, and to suppurative inflammation of the brain and its meninges. Shock cannot but be great, since, in addition to the damage done in the direct track of the bullet, the physical conditions are those most favorable to the development of strong hydraulic pressure, to wit, an unyielding bony case containing a semi-fluid mass. At short range the cranial comminution may be very extensive, particularly in the temporal and frontal bones, and especially in the orbital plates of the latter; and the destructive action of hydraulic pressure when the new bullet is employed has been experimentally demonstrated in wounds produced at a range of even from 600 to 800 yards.

Blood extravasations and serous effusions do harm chiefly through the pressure they produce; and in proportion as a way of escape is provided the damage from these fluids is lessened.

Infection of the damaged parts may readily occur through organisms introduced at the time of the injury, finding entrance at a later date along the shot track—or, in basal lesions, through the ear, the mouth or the nose—or carried in the blood-stream to develop in the clot, the effusion, or the exudate.

The recent changes in treatment can have no effect in diminishing shock; but they can have and have had not a little in preventing or relieving pressure symptoms, and in keeping out pyogenic organisms or counteracting their influence. They render it possible also to remove with safety most if not all of the bone fragments along the track of the ball, and often the ball itself, and thus avoid not only the immediate effects of the pressure of foreign bodies, but also the later mental disturbances which have not seldom shown themselves in individuals who have for months or even years been apparently well.

Though recovery may and at times does take place when no active treatment has been instituted, surgeons are now generally in accord in believing that the entrance wound should be thoroughly exposed, the opening of the skull enlarged by the application of the trephine, the track explored—and for this purpose a long, light, bulbous-ended aluminum probe is the best instrument—the ball, if reached, extracted, bone fragments removed, free drainage secured, and rigid antisepsis maintained. Devitalized tissue along the track of the wound may be scraped away, and if necessary a counter-opening with the trephine should be made. Though it is highly desirable that the bullet should be removed when it can be readily found and safely taken away, a counter-opening if necessary being made for the purpose, yet if the ball cannot be easily located—and often it will not when buried in the brain—extended search should not be made for it. Seldom will one be as fortunate as Fluhrer was, in 1884, when after tracking the missile through two counter-openings he was able to extract it and have his patient recover.

If at a later period suppurative inflammation shows itself, the adoption of antiseptic treatment as thorough as possible—irrigation and drainage being its most essential parts—may relieve the condition, though the chances of saving life will not be great.

To sum up, in brief, the results of the work of the last few years as regards gunshot injuries of the head, it is thoroughly established that active interference should as a rule be practised; that trephining does not add to the gravity of the case; and that the removal of ball, bone, and devitalized brain tissue can often in greater or less measure be effected, and will much increase the probability of recovery.

WOUNDS OF THE ABDOMEN.

As respects wounds of the abdomen, much has been done in determining clinically and experimentally their extent, the reasons for the great mortality always known to be associated with them, and, especially, the treatment that should be adopted. It is the latter that is of most interest.

What was but a few years ago a method advised on theoretical grounds—performing laparotomy, ligating bleeding vessels, suturing visceral wounds, cleaning the peritoneal cavity, and securing drainage —has now become a recognized procedure, respecting which the only questions are whether or not it shall be adopted in all cases, and if not, in which? It was in 1881 that Kinloch's operation was recorded; in 1883 Kocher's followed, the first which was followed by recovery; and in 1884 Bull's. In the latter year Parkes delivered his memorable address, as Chairman of the Surgical Section of the American Medical Association, in which were detailed the results of many experiments upon dogs, and in which direct operative interference was advised and urged. Since then numerous operations have been done, many papers have been published, and voluminous statistics have been collected, among others by Körte, Morton, Barrow, Martin and Hare, Reclus and Noguès, and Coley. By not a few surgeons operation in every case has been advised, while some have advocated abstention in all cases.

Neither of these extreme views should be accepted. Operative interference has been adopted sufficiently often to show not only its propriety but its necessity in very many cases. As a condition precedent to the determination of its place and value, the mortality rate of cases not operated upon should be ascertained. This with respect to those antiseptically treated has not as yet been done, except in a very limited way. Calculations based upon reports of military and civil practice prior to a few years ago, have but little present worth. In military operations the bullets were large and easily deformable, and the wounded came comparatively late under care; and in the treatment of all cases protection from septic infection from without was very imperfect. Of 23 patients treated without operation at the Chambers Street, New York, and Roosevelt Hospitals, in the years 1876–1884, 15 died, or 65 per cent. (Stimson) In the five years immediately preceding May, 1887, of 32 patients in the Charity Hospital of New Orleans 19 died, or 59.4 per cent. (T. G. Richardson). Of 91 cases collected by Reclus and Noguès, but 22 ended in death, or 24 per cent. At least a partial explanation of the extraordinarily low death-rate in this last-mentioned set of cases is to be found in the fact that it is compiled chiefly from journal reports, always largely those of fortunate and exceptional cases, and further that, in many instances, the symptoms

given are of questionable value as indicating penetration and perforation. It is not probable that as a rule three out of four cases of visceral lesion will be recovered from, regard being had to the ordinarily high grade of shock, the likelihood of serious hemorrhage, and the great danger of septic infection from germs introduced from without, escaping from the intestinal cavity, or even passing through the unbroken bowel wall. In no other region of the body is the development of a septic inflammation so much favored by the conditions of the wounded part; and under any method of treatment a large fatality must attend such injuries. Since these wounds began to be treated by laparotomy, collected statistics show a mortality rate of about 66.7 per cent. Of Körte's 64 cases 42 ended fatally; of Morton's 110, 74; of Barrow's 112, 74; of Martin and Hare's 129, 86; and of Coley's 165, 111. Reclus and Noguès estimate the death rate in laparotomies for intestinal perforation as high as 78 per cent., 57 deaths in 73 cases. A few operators, of large experience as these cases go, have been fortunate enough to save from 60 to 70 per cent. of their patients, but as eighteen is the highest number treated by any one up to the date of this writing, these statistics are perhaps of no very great value.

By personal communications from fifty-five of our American surgeons I am informed of the results of 174 operations (all that have been done by them), giving 123 deaths and 51 recoveries, a mortality rate of 70 per cent. As a rule, the percentage of recoveries has been in proportion to the number of operations done by the surgeon, as might be expected. The earlier the case is submitted to operation the better it is for the patient, if he is to be operated upon at all. A laparotomy done only after abstention has for a day or days been practised, after grave symptoms have presented themselves, and when death is imminent, promises very little; though occasionally, even under these desperate circumstances, recovery takes place. As in all other abdominal sections, the time element is an important one. A short exposure, ready discovery of the few perforations present, easy suturing, and early closure of the operation wound, cause much less risk than do hours-long searching for and stitching of multiple lesions. In Martin and Hare's table the mortality of operations completed in an hour was only one-third of that observed in those which lasted twice as long.

The operation is certainly demanded (1) when there has been discharge externally of blood, feces, urine, or bile, and (2) when the symptoms of collapse are present in marked and increasing degree; as a rule, it is vascular, not nervous, disturbance that has to be dealt with in the severer abdominal injuries.

Though a bullet, even of large calibre, may pass through the peritoneal cavity without causing any grave lesion, the chances are enormously against its doing so. Unless therefore the wound has been made by a ball of quite small calibre (22 or less), if penetration has occurred, laparotomy should be done so that whatever other treatment may prove to be needed may be adopted.

By operation the chances of recovery are increased because of (1) the removal of extravasations of blood, bile, urine, food, or feces; (2) the prevention of later discharges into the peritoneal cavity by closure of the visceral openings, and of bleeding by the ligation of wounded vessels; (3) the taking away of any infected foreign body accidentally

carried in, and the securing as completely as may be possible of a non-septic condition of the damaged parts. On the other hand, the chances of recovery are diminished on account of (1) the shock necessarily attending exploration and closure, especially if the search be a prolonged one; (2) the opening up of wounds already spontaneously closed; (3) the breaking down of protective adhesions that may have formed with the external wall of the abdomen, an adjacent viscus, or the omentum—adhesions that may and at times do rapidly form.

Not seldom one of the major difficulties encountered is in the determination of the fact of penetration. It is now known that the safest and best method of ascertaining whether or not the bullet has entered the cavity, is by opening up the wound in the wall. Senn, in 1888, introduced hydrogen-gas insufflation, but experience has shown that this test cannot be relied upon, since fecal accumulation may prevent the passage of the gas through the bowel, while adhesion, omental or other, to the internal wound of the abdominal wall, may prevent its escape externally. Further, in the use of the gas there is danger of breaking up adhesions which have already formed and are closing the intestinal openings, or of forcing out through an open wound infecting material that otherwise might have remained within the paralyzed bowel.

As respects the technique of laparotomy for gunshot wound, it is, in the main, that of abdominal section in general. A free incision is to be preferred to a short one, since it renders exploration, ligation, and suturing quicker and easier; and, as a rule having few exceptions, the opening should be in the median line and not through the wound. Perforations of the stomach or intestines are to be sewn up with the usual Lembert or modified Lembert stitch. If bowel wounds are so near together, or so large, as to make it unwise to close them because of the too great narrowing of lumen that would follow, the damaged part must be excised, and either end-to-end or lateral anastomosis established—by preference, probably, the former. No bleeding mesenteric vessel, whatever its size, should be left unligated. Lacerations of the liver or spleen, if other than slight, are to be sutured or plugged with sterilized or iodoform gauze, according to their extent. Serious damage to the kidney necessitates nephrectomy. In cases of perforation of the bladder, with escape of urine into the peritoneal cavity, laparotomy should be done at once; and the opening, if it can be found, which is not always the case, should be closed and the cavity cleansed. Whenever extravasation of any kind has occurred, thorough flushing of the peritoneal cavity with hot sterilized water should be practised, and a drainage tube should be used, to be removed as soon as the character of the discharge shows that it can with safety be dispensed with.

The chief operative difficulty, ordinarily, is in the determination of the number and location of lesions, especially of the intestine. Insufflation, of which so much was expected, has proved of little service and is now but rarely employed. Careful search with eyes and fingers must be made, and even then a wound or wounds may escape detection. Though exposure of any large extent of the intestinal tract is dangerous, yet the danger can be minimized by the thorough wrapping of the bowel in warm aseptic towels; and the likelihood of perforations being overlooked is less when the intestine is thus dealt with than when it is

run through the fingers and returned as examined, if the work be done at all hurriedly; and not seldom the condition of the patient will compel haste.

Consideration of the operative care and thoroughness demanded in this proceeding, and of the after-quietude of the patient which is essential to recovery, make it doubtful if in military surgery, except under unusually favorable conditions, these wounds can be treated with anything like the same success as in civil life. The new bullet may and probably will do less damage to the abdominal viscera than the old one, and going through the body may make a way for more complete drainage, but the large majority of those wounded will die, as they have heretofore.

POISONED WOUNDS.

BY

JOHN H. PACKARD, M.D.,

SURGEON TO THE PENNSYLVANIA HOSPITAL AND TO ST. JOSEPH'S HOSPITAL, PHILADELPHIA.

MUCH of the material contained in my former article on this subject [1] needs no modification. There have been, however, in this as in almost every other department of surgery, changes brought about by the adoption of the antiseptic system, as well as by further experience and observation. To set forth these changes, and to give an abstract of the published records of the profession, will be the object of this supplementary article.

In order to avoid repetition, it may be said here that the essence of the antiseptic system is thorough and absolute cleanliness, and destruction of septic material of every kind. For this purpose any wound is to be laid open, and sterilized; and it will not be forgotten that in many poisoned wounds the septic element is strongly marked.

DISSECTION-WOUNDS.

Axford [2] mentions that in the Chicago pork-packing houses the workmen, and especially the "shavers," are liable to suppurative cellulitis from wounds of the hands. In these cases the tendons are apt to slough and the bones to become necrosed. Antiseptic measures seem to have very little effect, and Axford suggests the early use of the actual cautery. A curious case is recorded [3] in which obstinate psoriasis seemed to result from a wound received during the dissection of a horse; the trouble was aggravated by a fresh infection a few years later, from the carcass of a tuberculous heifer.

For the prevention of trouble from dissection-wounds, the local use of the tincture of iodine has been strongly recommended by Louge.[4]

OTHER FORMS OF INJURY ALLIED TO DISSECTION-WOUNDS.—Lawson [5] reports a case in which very severe symptoms followed contact with a *jelly-fish*.

Anthrax.—In March, 1891, a case of anthrax was brought to the Pennsylvania Hospital. The patient, a woman 50 years of age, had been employed picking wool at an uptown factory, and three days be-

[1] See Vol. II., page 85.
[2] Physician and Surgeon, Jan., 1884.
[3] "V. S.," Lancet, Jan. 21, 1882.
[4] Gaz. des Hôpitaux, 13 Déc., 1887.
[5] Glasgow Med. Journal, July, 1891.

fore her admission noticed a small pimple on the left forearm; this rapidly grew worse, and was surrounded by a group of little pustules. She was very ill, and died in about thirty-six hours. Anthrax-bacilli were found in abundance in the pus, and in her blood after death. No clear history of the case could be obtained; nor did it appear that any other persons working with her had been similarly affected. Burrell has given [1] a very full report of a case of anthrax in a man 44 years of age, successfully treated by excision of the lesion. The bacteriological and microscopical examinations are described, and a bibliographical table is appended; the whole paper is worthy of careful study. Another case of successful excision has been reported by W. M. Baker,[2] and seventeen cases, with four deaths, by Mr. Davies-Colley.[3]

Insect-Stings.

Mention is made by Surgeon-Major E. R. Johnson [4] of an insect called the "pipsee fly," by the stings of which so many men were laid up that an order was issued for the wearing of boots and a protective dress. It is said to be smaller than a mosquito, and noiseless; it attacks the hands and feet, giving no pain at the time, but causing subsequently a conical elevation capped by a red blister, which soon becomes of a deep purple-black; the itching lasts for many days. A case is quoted from Paltauf [5] in which a woman, aged 30, was stung by a fly on the right eyelid; the next day there was local inflammation, with cerebral symptoms, followed by collapse and death. It is stated [6] that a surgeon in the East Indian Civil Service, while on a tiger-hunt, was attacked by hornets, and received over two hundred stings; erysipelas ensued, and proved fatal.

Such injuries would appear to involve special risk when inflicted on the head or neck. Thus fatal results are reported from a bee-sting on the forehead; [7] on the eyelid; [8] from a wasp-sting on the side of the neck,[9] death occurring on the ninth day. Newton [10] records the occurrence of alarming symptoms from the sting of a honey-bee in the facial vein; and another, in the upper part of the side of the neck of a healthy girl, aged 22, is said by Hocker [11] to have produced like effects. A singular case is reported by Uhthoff [12] in which a man about 40 years old was stung "on the right eye" by a "wasp-fly." There was swelling and loss of sight on the third day; the perception of light gradually returned, and a week later the sight is said to have been much improved. Nothing was revealed by ophthalmoscopic examination. A case of death from a wasp-sting is recorded,[13] in which it is said that a Mr. Day, M.R.C.S., ascribed the fatal result to syncope from the pain. Alarming collapse was observed by Thomas [14] in a man aged 56, stung on the middle finger by a wasp.

[1] Trans. American Surgical Association, vol. xi., 1893.
[2] Brit. Med. Journ., June 14, 1884. [3] Med. Chir. Trans., vol. lxv., 1882.
[4] Appendix A to Twentieth Annual Report of the Sanitary Commissioner with the Government of India, 1883. [5] Gaillard's Med. Journal, Jan., 1892.
[6] Lancet, Oct. 13, 1883. [7] Brit. Med. Journ., July 22, 1882.
[8] Lancet, June 16, 1883. The patient, a farmer aged 59, died in half an hour; he had twice before been "very ill" from bee-stings.
[9] Leadman, British Med. Journal, Sept. 21, 1889. [10] Lancet, Aug. 2, 1890.
[11] Nashville Journ. of Med. and Surg., Aug., 1883. [12] Brit. Med. Journ., Sept. 26, 1885.
[13] Lancet, Aug. 5, 1883. [14] Ibid., Oct. 7, 1893.

Urticaria of a severe type has been noted by Cobleigh [1] as a result of bee-stings. A more serious result from a wasp-sting is reported by Prudden.[2] A man, aged 63, was stung on the finger in August; swelling persisted, and a tumor developed occupying the last two phalanges; this was removed by amputation in December, and was found to be a spindle-celled and round-celled sarcoma.

A number of cases of *spider-bite* have been recorded. Ramsdell [3] reports ten, none of which were fatal; Carhart,[4] two. Wade [5] gives a case of spider-bite of the scrotum, in which very grave symptoms (restlessness, delirium, pain in back and legs, numbness and tingling in extremities, dyspnœa, slow pulse, and incoherent speech) were present, and great depression lasted for ten days. He mentions two other instances, in one of which recovery took place in a week, in the other not for a month. A very similar case, occurring in his own person, has been reported by Lewis.[6] In another, recorded by Tompkins,[7] the patient was a woman; she nursed her child, and it became very ill, but both recovered. As to the treatment of these cases, Carhart used morphia and permanganate of potassium hypodermically; Wade gave morphia and atropine hypodermically, and bromide of potassium and carbonate of ammonium internally. Tompkins relied upon whiskey, quinine, and nux vomica, with ammonia locally.

It is stated [8] that a death occurred from the bite of the "katipo," a brown spider with red spots; and that Cockburn has reported a dozen cases of this kind treated successfully by the internal administration of strychnia. Another case of the bite of this insect, in a boy aged 5, is recorded by Ross;[9] the sting was inflicted on the neck, behind the ear, and the symptoms, at first grave, passed off in a week's time. The katipo (*Latrodectus mactans*, *verecundus*, or *scelio*) is said to be very common in New Zealand. In a paper by Wilson [10] on poisoning by the bite of the southern spider, a description is quoted from the Encyclopædia Britannica, by which it would appear that this insect has a poison-apparatus very like that of the rattlesnake. A spider-bite on the chin is said [11] to have caused the death of a prominent official in South Carolina by giving rise to erysipelas; but there is nothing to show that the nature of the poison had any special significance.

A case of *tarantula* bite is reported by Wrenn;[12] the patient, a girl a little over three years old, was stung in the groin in the evening, and died in a convulsion at 1 P.M., the next day. Fuller [13] states that he has twice seen cases of this kind in men engaged in unloading cargoes of bananas. Both patients recovered.

The late Professor Leidy said [14] that according to a letter received by him from Dr. Gonzalez of Durango, Mex., *scorpions* abound in that district, and their sting is frequently fatal, especially in children, who

[1] Cincinnati Med. News, Oct., 1884.
[2] Medical Record, Feb. 21, 1885.
[3] Trans. of Texas State Med. Assoc., March, 1885.
[4] Texas Courier-Record of Medicine, Feb., 1889.
[5] Southern California Practitioner, Aug., 1889.
[6] North Carolina Med. Journal, Oct., 1894.
[7] Med. Bulletin, Sept., 1884.
[8] Lancet (Australian Correspondence), June 13, 1891.
[9] Australasian Medical Gazette, April, 1891.
[10] Trans. Southern Surg. and Gynæc. Assoc., vol. v., 1893.
[11] Med. News, Sept. 15, 1883.
[12] Occidental Med. Times, July, 1890.
[13] Med. Record, Aug. 2, 1884.
[14] Trans. of the College of Physicians of Philadelphia, 1886.

die in a short time in convulsions. Two fatal cases, in adults, are reported by O'Hara.[1] On the other hand, Banerjie[2] records forty-six cases, all of which ended in recovery; he recommends the local use of chloroform, chloral, or chloral and camphor. Poredi[3] says that cocaine by injection gives relief, localizing the pain.

It may be mentioned here that Ricord[4] has employed the peroxide of hydrogen with success in a case of hornet-sting, and suggests its trial in other cases of animal poisoning. By Briggs[5] the "bugle-weed" (*Lycopus virginicus*) is said to have been used with success in a case of centipede-bite, as well as in other instances of poisoning by insect-stings.

Wounds by Poisoned Arrows.

White[6] has reported the case of a servant-girl accidentally wounded by a poisoned arrow kept with some other weapons. The prominent symptoms were failure of circulation and respiration; and the poison was thought to be curara.

Stanley is said[7] to have found that the natives of the Lower Congo district used the powder of *dried red ants*, mixed with palm-oil, for poisoning their arrows. It is stated that the wounds produced had terminated fatally "directly."

By the Akas,[8] a brown paste, chiefly composed of the root of *Aconitum ferox*, is used. Three cases are reported, two ending fatally in a few hours, the third followed by slow convalescence. The people of the country, an Indian district near Bhootan, had an aromatic bark (from a species of laurel) which they said was an antidote when chewed.

Snake-Bites.

The reader who wishes to possess himself of the existing information in regard to snake-venom will find a good history of the earlier researches made on this subject in an article by Fletcher;[9] Brunton[10] has written on snake-venom and its antidotes. Cobra-poison has been studied and experimented with by Aron,[11] by Kanthack,[12] by Ragotzi,[13] and by Wolfenden.[14] Reference may also be made to some further investigations on snake-poison by Sir Joseph Fayrer.[15] The poison of the copperhead has been experimented with in this country by Ott.[16] But the most satisfactory results have perhaps been attained by Mitchell and Reichert[17] in their investigation of the poison of rattlesnakes and copperheads. They have been able to determine the existence in the venom of three proteid principles, which they call *venom-peptone*, *venom-globulin*, and *venom-albumin*. Of these the globulin is the most intensely poisonous, the peptone being less so, while the albumin has not

[1] Indian Med. Gazette, March, 1884.
[2] Lancet, Oct. 1, 1892.
[3] Indian Med. Record, Dec. 1, 1892.
[4] Med. Record, Feb. 8, 1890.
[5] Trans. Texas Med. Assoc., 1886.
[6] Lancet, April 13, 1889.
[7] Ibid.
[8] Med. History of the Aka Expedition, 1883.
[9] Am. Journal of the Med. Sciences, July, 1883.
[10] British Med. Journ., Jan. 3, 1891.
[11] Zeitschrift für klinische Medicin, sechster Band, Art. xx. und xxiii.
[12] Journal of Physiology, vol. xiii., 1892.
[13] Virchow's Archiv, Band 122, 1890.
[14] Journal of Physiology, vol. vii., 1886.
[15] Lancet, Feb. 2, 9, and 16, 1884.
[16] Virginia Med. Monthly, Feb., 1883.
[17] Medical News, April 28, 1883.

yet been completely isolated. It is stated by these gentlemen that the poisons of the rattlesnake, copperhead, and moccasin are capable of being destroyed by bromine, iodine, bromohydric acid (33 per cent.), sodium hydrate, potassium hydrate, and potassium permanganate. In another paper [1] they set forth further studies, including one on cobra-venom, and showing that the difference in action between this and the poison of our American snakes is the result of the difference in their chemical and physiological constitution.

On the subject of snakes generally, the reader will find much information in an article headed "Reptiles, Poisonous," by Yarrow.[2]

According to some observers, *fright* has much to do with the gravity of many cases. Thus, Creed [3] mentions an instance of death from the bite of a non-venomous lizard; and another in which alarming symptoms ensued upon a puncture with a splinter, mistaken by the patient for a snake-bite. Hood [4] and V. Richards [5] have expressed the same view.

Richards [6] states that a poisonous wound may always be distinguished, upon incision, by its showing a red currant-jelly-like clot.

Long [7] reports a fatal case of "krait" bite, in which there were no local symptoms; the patient had probably absorbed the poison into some fissure in his mouth, while sucking the wound.

Several cases have been recorded in which snake-bites were very rapidly fatal. Roberts [8] states that a colored boy, 7 or 8 years old, was bitten on the hand, fell forward, and was again struck in the face; he was picked up, convulsed, by a man, who ran with him toward a house near by; but "the boy was dead before he had run 75 yards." Blackwood [9] mentions a colored child, 3 years old, bitten on the eyebrow by a "yellow rattler," and dying in ten minutes. He says that decomposition set in very early, and that the blood in the child's body was fluid. Another case, in which a Hindoo child, aged 5, succumbed in ten minutes, is recorded by Burgess.[10] Banerjie [11] saw a man die within an hour from the bite of a viper (*Echis carinata*). Sometimes death takes place at a remote period. Watkins [12] reports the case of a boy, 17 years old, bitten by a moccasin on the instep, who seemed to recover promptly; but about a year afterward moist gangrene of the foot and leg began, and on the fourth day ended fatally. This patient is said to have shown "an inclination to bite anything and anybody close at hand,—his bed-clothing, self, and friends."

Hemorrhages from the stomach and kidneys have been noted by Reilly [13] in a man aged 25, who died on the seventh day, and by McDonnell [14] in a case which proved fatal in a little over three hours.

CONSEQUENCES OF SNAKE-BITES.—The curious fact has been noted that there is in some of these cases a tendency to the annual recurrence of the symptoms of poisoning. Yarrow [15] records two such instances

[1] Smithsonian Contributions to Knowledge, No. 647, 1886.
[2] Buck's Reference Handbook of the Med. Sciences, vol. vi.
[3] Australasian Med. Gazette, July, 1884.
[4] Ibid., Aug., 1887.
[5] Indian Med. Gazette, Feb. 1, 1882.
[6] Ibid., Jan. 2, 1882.
[7] Indian Med. Gazette, Nov. 1, 1882.
[8] Southern Practitioner, Sept., 1888.
[9] Med. Register, March 24, 1888.
[10] Lancet, May 3, 1884.
[11] Indian Med. Gazette, Dec., 1886.
[12] New Orleans Med. and Surg. Journal, Oct., 1888.
[13] Lancet, June 10, 1893.
[14] Australasian Med. Gazette, Feb., 1892.
[15] Am. Journ. of the Med. Sciences, April, 1884; Med. News, June 4, 1887.

observed by himself, and quotes others from Stockbridge, Coleman, and Piffard. He says that such an occurrence has been far more frequently met with after the bites of copperheads and moccasins than after those of the rattlesnake or viper. Another case is reported by Sharp.[1] Spalding[2] mentions the case of a man 47 years old, who died of septicæmia in consequence of the bite of a "Crotalus adamanteus" said to have been ten feet long.

It may be well to give here the following references to reported cases: Kaufmann[3] (63 cases observed in Switzerland); Sharp[4] (five cases); Alcock;[5] Reilly[6] (two cases of "koorial" bite, one fatal); Thomas[7] (two cases in children, both fatal); Carhart;[8] Sewall;[9] Fayrer.[10] Non-fatal cases of bites by the puff-adder have been published by Whitty[11] and by McIntyre.[12]

Cases of viper-bites have been reported by Lafitte[13] (four cases; one, in a child, fatal); one (not fatal) by Callias;[14] others (not fatal) by Escard,[15] Chavasse,[16] and Green.[17]

TREATMENT OF SNAKE-BITES.—Upon this subject there has been much written, and many opinions expressed, based upon theory, experiment, and clinical observation. One thing is certain: there is no specific remedy, which being given to a bitten person will effect his cure. There are substances which will neutralize or destroy the venom when brought in contact with it; but they cannot be depended upon to follow it up in the circulation and prevent its deadly effect. When the amount of poison absorbed is small, either because only a little has been received or because a ligature is promptly applied, recovery may take place under almost any supporting treatment.

Richards[18] expresses the opinion that the poison of different snakes acts very differently; thus, cobra-venom affects the nerve-centres in the medulla, while that of the daboia is a true blood-poison. This fact should be borne in mind in estimating the value of the various remedies proposed or employed.

Memminger[19] reports the case of a man about 30 years old, bitten in the finger by a rattlesnake; a ligature was at once put round the arm above the elbow, and Dr. M. saw him within ten minutes after the bite was received. Whiskey was freely given, and ammonia was repeatedly injected into a vein; an Esmarch tourniquet was applied just below the shoulder, and from this downward an elastic bandage, so as to empty the limb of blood. About once an hour the tourniquet was slackened for a few seconds, an alarming collapse following on each occasion; this process was repeated six times, and then the tourniquet was taken off. Recovery was complete in a few days.

[1] Gaillard's Med. Journal, April, 1888.
[2] New York Med. Journal, July 19, 1884.
[3] Corr.-Blatt für Schweizer Aerzte, 15 Nov. und 1 Dec., 1892.
[4] Gaillard's Med. Journal, April, 1888.
[5] Indian Med. Gazette, June, 1888.
[6] Ibid., Sept., 1890.
[7] Med. Record, Feb. 1, 1890.
[8] Texas Courier-Record of Medicine, Feb., 1889.
[9] Med. Record, Nov. 21, 1891.
[10] British Med. Journal, Oct. 1, 1892.
[11] Ibid., June 1, 1889.
[12] Lancet, July 19, 1890.
[13] Mém. et Bull. de la Soc. de Méd. et de Chir. de Bordeaux, 1889.
[14] Bull. de la Soc. de Méd. prat. de Paris, 11 Avril, 1889.
[15] Arch. de Méd. et de Pharm. Mil., tome xiii., 1889.
[16] Ib., tome xviii., 1891.
[17] British Med. Journal, June 2, 1894.
[18] Lancet, July 1, 1882.
[19] Med. News, Sept. 14, 1889.

Permanganate of Potassium.—In my former article, mention was made in a foot-note of this remedy, which has since been extensively used, and is at the present time regarded with much favor by some of the leading authorities. Richards[1] advises the use of a 5-per-cent. solution; Quatrefages[2] regards a 1-per-cent. solution as sufficient, with ligature of the limb and kneading of the tissues about the wound. By some, the remedy has been employed internally as well as locally; thus Bories,[3] in the case of a man aged 35, seen four hours after the bite of a rattlesnake in the calf of the leg, injected ½ gr. into the arm, and gave gr. ij. by the mouth every hour. Barber[4] reports nine cases of rattlesnake-bite in which the permanganate was used with success. Much testimony to its value has been afforded by observers in India.[5] In some of the reported cases, other remedies have also been given, such as quinine, ammonia, or whiskey. Badaloni[6] states that in experiments on animals with viper-poison, he found the permanganate inefficient. Shortt[7] claimed that it was the potassium which was of real value; and recommended "saturating the system so that all the secretions are alkaline." This view, however, is absolutely rejected by Richards. Gaston,[8] reporting a case successfully treated with permanganate locally and ammonia internally, claims the credit of the discovery of the former agent for Dr. Tichenor, of Baton Rouge, La.

Strychnia.—This drug has recently been advocated by many Australian practitioners,[9] and by some in India. It has been given either by the mouth or hypodermically, with the obvious purpose of stimulating the nervous system. It has sometimes been pushed to the extent of inducing tetanic spasms, as in cases reported by Cadge and Pratt,[10] and by Reid.[11] But it seems to have given favorable results in all the instances published. Banerjie[12] gives seven cases, and Thomas[13] five. In two, reported by Thwaites,[14] whiskey was also administered.

Other Remedies.—Darwin[15] says that he saw a man bitten by a viper (*Echis carinata*) successfully treated by having a number of *chickens* applied, one after another, by their vents to the wound. Josso[16] gave *jaborandi* freely to a woman bitten by a European viper; she perspired freely, and recovered, but the case does not seem to have been a grave one. Browne and Smyth[17] report from South Africa a case of cobra(?) bite treated successfully by the hypodermic use of *morphia* and *ammonia*. Another writer[18] doubts that the snake was a cobra. McCall[19] recommends *whiskey* and a *clay poultice*, on the strength of two cases so treated. Hopkins,[20] in the case of a colored child aged 4, bitten three times by a copperhead, gave whiskey and used a hot-water dressing, with a good result.

[1] Indian Med. Gazette, Jan. 2, 1882.
[2] Comptes-rendus des Séances de l'Acad. des Sciences, Feb. 20, 1882.
[3] Polyclinic, Oct. 15, 1883. [4] Therapeutic Gazette, Jan. 15, 1892.
[5] Indian Med. Gazette, Jan. 2, Feb. 1, June 1, Oct. 2, Nov. 1, 1882, Dec., 1887.
[6] Lancet, May 5, 1883. [7] Ib., May 6, 1882.
[8] Brooklyn Med. Journal, May, 1888.
[9] See a number of articles in the Australasian Med. Gazette for 1890, 1891, 1892 and 1893.
[10] Indian Med. Gazette, Oct., 1892. [11] Australian Med. Journal, March 15, 1894
[12] Indian Med. Record, July 1 and Nov. 1, 1892. [13] Ib. Dec. 1, 1892.
[14] Trans. Intercolonial Med. Congress of Australia, Jan., 1889.
[15] Indian Med. Gazette, June 1, 1882.
[16] Gaz. Hebdomadaire de Méd. et de Chirurgie, 22 Déc., 1882.
[17] Lancet, April 21, 1883. [18] "G. H. F.," Ib., May 12.
[19] Med. Standard, April, 1888. [20] Med. Record, Oct. 19, 1889.

Quinine and whiskey were given with success by Vinke[1] to a boy aged 13, bitten by a rattlesnake. Carpenter,[2] in two cases of copper-head-bite, applied *iodine* externally, and gave *compound tincture of iodine* internally, with success. Karlinski[3] records observations and experiments with the poison of vipers, and advocates a 1-per-cent. solution of *chromic acid* as an antidote. Kaufmann, of Paris, also recommends this. A remedy called *Tiriyaq*, stated by a clergyman named Lorbeer to be an antidote for krait-venom and cobra-venom, has been reported upon as worthless by Richards and Simpson.[4]

Preventive Inoculation.—Waddell,[5] reporting some experiments confirming the belief that snake-venom is not auto-toxic, suggests that this may be in favor of preventive inoculation. Sewall[6] says that from his experiments it appears that "repeated inoculation of pigeons with sub-lethal doses of rattlesnake venom produces a continually increasing resistance toward the injurious effects of the poison, without apparent influence on the health of the animals." Jacolot[7] states that at Tuxpan, on the Gulf of Mexico, inoculation has long been practised; the patient eats the bulb of a certain native plant, and is then inoculated with the venom-fang of one of the most poisonous snakes.

It would seem as if the immediate risk and inconvenience of inoculation were too great to be counterbalanced by a mere chance of immunity from a remote danger, which might never actually occur.

Bites of Other Animals.

Rat-Bites.—Two cases have been reported of very grave poisoning from rat-bites; one in a boy aged 11,[8] the other in a man aged 25.[9] In both there were symptoms of septicæmia; in the man, the local cellulitis was so severe as to cause gangrene.

Human Bites.—Of these injuries two cases have been reported, one by Whiting[10] and the other by J. S. Carpenter.[11] In each there was severe cellulitis of the affected part—a finger—and amputation was ultimately performed. Carpenter's patient had decided septicæmia, which for a time threatened his life.

Morrow[12] relates the case of a man who was severely bitten on the finger by another man far advanced in leprosy; seven years afterward the disease was developed in the injured part, and became constitutional. The patient firmly believed it to have been communicated by the bite; but it seems to me that this must be a matter of doubt.

[1] St. Louis Courier of Medicine, Dec., 1883.
[2] Med. News, April 21, 1883.
[3] Fortschr. der Medicin, 15 Aug., 1890.
[4] Indian Med. Gazette, Aug., 1889.
[5] Lancet, June 15, 1889.
[6] Journal of Physiology, vol. viii., 1887.
[7] Quoted in Med. Record, Dec. 5, 1891, from Arch. de Méd. Navale.
[8] Cook, Indiana Med. Journal, Oct., 1885.
[9] Thompson, Med. News, May 31, 1884.
[10] Peoria Med. Monthly, May, 1885.
[11] Med. Record, May 2, 1885.
[12] A System of Genito-Urinary Diseases, Syphilology and Dermatology, vol. iii., Art. Leprosy, p. 593.

HYDROPHOBIA.

BY

J. McFADDEN GASTON, M.D.,

PROFESSOR OF THE PRINCIPLES AND PRACTICE OF SURGERY IN THE SOUTHERN MEDICAL COLLEGE, ATLANTA, GA.; PRESIDENT OF THE AMERICAN ACADEMY OF MEDICINE; EX-PRESIDENT OF THE SOUTHERN SURGICAL AND GYNÆCOLOGICAL ASSOCIATION, AND OF THE SECTION OF ANATOMY AND SURGERY IN THE AMERICAN MEDICAL ASSOCIATION.

A MOST remarkable incredulity in regard to the existence of the affection known by the designation of rabies, in animals, and by that of hydrophobia in the human race, has been manifested by certain members of the medical profession. No deduction from facts avails anything to convince these gentlemen of the reality of the phenomena, which constitute a group of symptoms, attributed to inoculation, by bites or other means, of the virus from animals affected with a peculiar form of disease involving the secreting and nerve centres. It is generally recognized that there is no remedy available for the cure of hydrophobia when once developed in the human being; and the isolated cases which are supposed to have been cured by various agencies are set aside by well-founded doubts as to the diagnosis. This question of simulated symptoms does not enter into our consideration of genuine cases; and it is passing strange that intelligent members of the medical profession should be misled by such cases into a denial of the facts brought out by the history of this disease in animals and in mankind. The great variety of developments presented in different subjects has no doubt much to do in awakening the incredulity of those who have read the reports of cases of hydrophobia without seeing a patient under its dreadful spell. In this instance, emphatically, "seeing is believing." No argument will be required to convince any observer of the reality of the disease when brought in contact with a subject under its influence, and he will then become impressed with his utter impotency in affording relief.

This disorder presents a great variety of modifications in different subjects, and yet there are certain features which are uniformly observed as characteristics of these cases, and which progress with such intensity as to terminate fatally in most instances. Active means of treatment applied early and vigorously have availed little toward averting death, and by whatever name this disease may be recognized, the reality of it cannot be doubted by any one who has ever met with it and had occasion to treat it. As to the propriety of characterizing this train of neurotic troubles by the term hydrophobia, which indicates only one of the symptoms, not invariably present, there may be

grounds for a difference of opinion. Yet this designation, being so generally understood in its application to a special form of disease, has been thought by all writers on the subject best suited to convey an adequate idea of it, and hence this nomenclature should be continued. Without a proper understanding of the usual course of hydrophobia, the reader is not prepared to enter upon a consideration of the various phenomena which are developed in the progress of this disorder. It seems therefore proper, in the outset, to present the main features of a typical case reported by M. J. Girode, in the Archives de Physiologie for February 15, 1887.

Henry B., an Italian, 28 years old, was received for treatment April 10, 1886. He had been bitten by a small slut dog two months previously, and the wounded finger had been compressed so as to favor the discharge of blood at the time. The dog died in the course of three days, without taking either food or drink. The patient kept well until the 9th of April, when he awoke with a severe headache. He went to work, and though he took little food at dinner, he continued in service. He began to feel badly about two o'clock, and when offered a drink of water the glass was pushed away, which act was followed by temporary collapse and impaired consciousness. About three o'clock of the same day he returned to his house, and remained there until four o'clock in the afternoon of the 10th of April, when there were presented headache, sleeplessness with restlessness, delirium, some flow of saliva, inability to swallow either liquids or solids, constriction of the throat, and marked irritability; he refused to see his friends, who endeavored to control him. Upon his arrival at the hospital, the face was pale, the features animated, the eyes bright and moist, the eyelids widely opened at times, giving an appearance which was terrifying. The patient had entire control of his movements, and his mind was clear, while there was great loquacity; yet in the middle of a sentence he would suddenly stop from spasm of the pharynx. This condition ceased after a few minutes, with expectoration of white, frothy mucus. The pharyngeal spasms returned in from five to ten minutes, and were more frequent when the patient talked. He was constantly asking for drink, but on attempting to bring the glass to his lips, his head was at once turned away. If the effort was made to force him to drink, he was immediately seized with a violent spasm. The repulsion for solids was equally marked. There was no evidence of pain, when the puncture was made in administering a hypodermic injection of morphine. The patient had no hallucinations, and exhibited no tendency to violence either toward himself or others. The skin was moist; temperature 38.2° C. (100.7° F.); pulse 116, soft and fluttering. Urine was passed naturally, and contained neither albumin nor sugar. The patient was extremely restless during the night of April 10–11, his restlessness not being controlled by morphine and chloral. On the following morning, the sight of persons about him began to terrify him. The skin was still moist; pulse 120; temperature 38.4° C. (101.1° F.). At times he was suffocating from the severity of the pharyngeal spasm, sprang from the bed, and rushed to the window for air. The dysphagia was persistent and complete. The attempt was made to introduce fluids through a tube. As soon as a few drops had passed into the mouth the whole was suddenly expelled by a spasm of extreme violence. No urine had been passed since early morning; stool absent.

3 P.M.—The spasm had become more violent, with hallucinations of terror, but no tendency to bite. Temperature 39.6° C. (103.3° F.). Pupils punctiform. The administration of chloral and injections of morphine now produced no relief; but on the contrary the delirium became rapidly more and more marked, so as to require the camisole.

4 P.M.—The agitation was now terrific, with rigidity of the neck and limbs. Had passed no urine since morning. Pulse bounding, 160 beats to the minute.

5 P.M.—Collapse. Cessation of cries, and cyanosis. White, frothy saliva flowed from the mouth with each expiration. Subconjunctival ecchymosis. Corneal reflex almost absent.

6 P.M.—Eyes largely opened; pupils dilated; corneæ dry. Profuse cold sweat. Respiration irregular. Tympanites.

7 P.M.—Twenty-two respirations per minute, and very irregular. Pulse thready and tremulous, and could not be counted. Head burning; extremities cold. Pupils very large. One hour later, dead. M. Roux made inoculations with the spinal cord in rabbits, which died with the typical symptoms of rabies, thus confirming the diagnosis from clinical observation.

The prevailing opinion of the profession is that this disorder consists in disturbance of the spinal nervous system, without any material involvement of the brain or the intellectual faculties, and that it results from inoculation of the virus from rabid animals. Facts sustain the position that a toxic condition developed in dogs, cats, wolves, foxes, etc., is propagated by their bites to other animals, and to human beings. This is followed by a certain train of symptoms, accompanied by spasm of the muscles, of the throat, and inability to swallow fluids. This condition is followed by rapid exhaustion of the vital forces, which usually terminates fatally in from two to five days.

The largest number of cases occur within thirty days from the infliction of a bite, but they may be delayed for one or two years, or even a longer period. The poison remains inactive until some adventitious circumstance develops its effect. The original article upon this subject, in the first volume of this work, covers the ground occupied by the investigations up to that time. It will be supplemented by some data of a general nature, after which my personal experience with hydrophobia will be presented.

The spinal cord of infected animals gives marked indications of the poison, but the spinal fluid is not infectious, and no toxic property has been eliminated from any of the secretions or tissues of the body. While the saliva conveys the disease when introduced beneath the cuticle, no specific micro-organism has been detected in it or other fluids. It was observed by Holman that concentrated virus injected under the skin did not infect animals, and even gave immunity to some extent in dogs, rabbits, and monkeys. The "*virus fixe*" was used by Ferran by injection into the subcutaneous tissues of man in his treatment of hydrophobia; but such injections sometimes proved fatal to dogs in the series of cases subjected to the action of this virus by Pasteur. The great problem of the propagation of rabies from one dog to another by inoculation, has been satisfactorily solved by Pasteur's experiments. He has also demonstrated the practicability of protecting dogs from the disease by repeated introduction of the attenuated virus; and no doubt if human beings would submit to repeated injections as a prophylactic measure, they might in like manner secure immunity. The effort to arrest the progress of rabies in the human system during the incubating stage, after the infliction of bites by rabid animals, has been crowned with a measure of success; but this result depends upon the antidotal effect of the attenuated virus upon a different basis from its prophylactic virtues. It is now held by some authorities that an animal may be to such an extent under the influence of rabies, during incubation, as to propagate the disease; and if so, a

human being having received a bite from a rabid animal, may already have the disease pervading his system during the stage of incubation. A case of unmistakable hydrophobia treated by a modification of the Pasteurian method, with a favorable result, is recorded by Louis McLane Tiffany, in his article on hydrophobia in Sajous's Annual for 1893. It was under the care of Auguste Murri, Director of the Pasteur Institute at Bologna.

A man, 22 years old, was bitten in the calf of the left leg by a rabid dog, on March 3, 1892, and came under treatment four days afterward. Forty-nine inoculations of 25 minims were given during a period of twenty days, emulsions containing the medullæ of the 14th, 13th, 12th, 11th, 10th, 9th, and 8th days being used until the 6th day, on which medullæ of the 6th and 5th days were injected, and from the 5th to the 10th day, those of six, five, four, and three days, down to the end of treatment. On the night of March 26, ugly symptoms developed. Intense pain along the spinal column, a sensation of heat throughout the body, sleeplessness, and loss of power in the lower extremities were followed on the 28th by vomiting and fever. By the 29th the paralysis of both legs was complete, and there was retention of both urine and fæces. Murri, seeing that in this case the ordinary means of inoculation were too slow, determined to try intravenous instead of hypodermic injections. Taking into account the failure of the ordinary treatment, intravenous inoculations were begun on the 29th, with an emulsion carefully prepared from cords of six, five, four, and three days. At first two injections daily were given, afterward only one; and from April 1 there was constant improvement, until by April 17 the disease was completely conquered. The convalescence in this case was constant but protracted; the reflexes, which had been lost, returned; and the paralysis gradually gave way to a restored muscular activity. Murri concludes that the history of this case demonstrates that Pasteur's method is not only of value in preventing hydrophobia, but that it may be so modified as to be an efficient remedy against the developed disease. He declares that the dog inflicting the bite in the above case was certainly rabid; but it might be urged that the attack had resulted from the inoculations, rather than from the bite. These, however, would not be likely to cause the genuine paralytic rabies encountered in this patient.

The early experiments of Pasteur upon monkeys and rabbits led to interesting developments, in the verification of a gradual diminution of the force of the attenuated rabic virus in the former, and its intensification in the latter. It is even claimed that the augmentation of the effects, by its passage through the bodies of a number of rabbits, imparted to it all the properties of the original canine virus. Thus he was enabled to lessen or increase the force of the attenuated rabic virus, by using the monkey or the rabbit for the medium of its transmission.

The process of drying the medullæ of animals affected with rabies, was, however, found to be a more convenient and satisfactory method of getting the exact strength of the virus for use, and has served as a basis not only for experimentation, but for treatment of hydrophobia, during the period of incubation, in the human subject.

An emulsion of the graduated desiccations of the spinal cords of infected animals, was first tested upon the human being, in the person of Joseph Meister, on July 4, 1885, with satisfactory results; and its use was afterwards repeated upon other persons, so as to illustrate not only its freedom from immediate serious effects, but eventually to demonstrate a salutary result in giving immunity from rabies. This had been

shown conclusively before, in the experiments upon dogs, but there was no positive assurance of a like result being secured in its application to a human being, until this courageous young man voluntarily submitted himself to the test. With the lights thrown upon the matter by the diverse influence of inoculation upon the monkey and the rabbit, Pasteur was not in a position to guarantee complete exemption from risk, in employing even greatly attenuated rabic virus for inoculation of man. With the boldness growing out of his previous scientific investigation the great *savant* essayed to explore an unknown field, and fortunately his experiment proved a success. In a lecture upon hydrophobia to the students at the Southern Medical College, Atlanta, Ga., on November 10, 1884, I referred to the preventive inoculations of Pasteur upon dogs, and used the following language touching its extension to mankind:—

"A young German student has offered himself as the first human subject, and will hand his name down to posterity as a martyr, or will live to enjoy the plaudits of mankind. . . . Say not that it is pride or vainglory which leads a young man to risk his life in a cause like this; but give him credit for the purest and noblest impulses which can actuate man's conduct in this world." I have now only to add, that Joseph Meister is entitled to a monument more lasting than brass or stone.

The inoculations have only been generally performed since the beginning of 1886. The number of persons inoculated from that time until July, 1888, at the Pasteur Institute, at Paris, was 5374. Excluding the deaths of those who developed rabies before the treatment was completed, because the nervous centres were involved before the treatment began, the total mortality for 1886 was 0.93 per cent.; for 1887, 0.67 per cent.; for 1888, 0.55 per cent. The gradual perfecting of the method since has been attended with a corresponding decrease of mortality in the succeeding years. It was stated by M. Pasteur in 1890, that among the last thousand bitten by rabid animals and inoculated by the intensive method, in his Institute, not a single death had resulted, and that there had not occurred any unsuccessful case under this treatment.

The following table from The New York Therapeutic Review, of September, 1893, kindly sent me by the editor, Dr. Paul Gibier, shows the results up to that year:—

Years.	Persons Treated.	Died.	Death Rate, per cent.
1886	2671	25	0.94
1887	1770	14	0.79
1888	1622	9	0.55
1889	1830	7	0.38
1890	1540	5	0.32
1891	1559	4	0.25
1892	1790	4	0.22

The great majority of those who have been treated at the Paris Institute had been bitten by dogs, which had been examined by veterinary surgeons and recognized as rabid, or in which hydrophobia had been evidenced by inoculations on small animals, or by the death of some other person or animals bitten by them.

It will be noted that the mortality has steadily lessened, and it is con-

fidently expected that, with the improved technique and the observance of due precautions in every stage of the treatment with the intensive virus, the factor of fatality will be entirely eliminated from the Pasteur Institute.

The results of preventive inoculation against hydrophobia in the Chicago Pasteur Institute since its inauguration, July 2, 1890, are given by Dr. A. Lagorio on November 18, 1893. To date, 302 persons have been treated, as follows: 104 bitten by animals recognized and ascertained to be rabid by the experimental proof, made in the laboratory, or by the death of other persons or animals bitten by the same animal; 126 bitten by animals recognized to be rabid by the symptoms of the disease shown during life; 72 bitten by animals strongly suspected to be rabid; 282 persons were bitten by dogs, 7 by horses, 7 by cats, 3 by skunks, 2 by wolves, 1 by a mule. One death was reported among the patients treated, thus giving a mortality of only 0.33 per cent., corresponding very much to that for the same time at Paris. Of the persons treated, 185 came from Illinois, 32 from Iowa, 23 from Indiana, 21 from Kansas, 9 from Ohio, 5 from Missouri, 5 from Arizona, 4 from Minnesota, 4 from Michigan, 4 from Louisiana, 3 from Tennessee, 3 from Kentucky, 2 from Texas, 1 from Wisconsin, and 1 from South Dakota.

The following table contains similar information with regard to the work of Dr. Paul Gibier at the New York Pasteur Institute for the year 1892, this being the third year of its operation:—

Statistics of Treatment.	A	B	C
Bites inflicted on head and face { Simple	0	1	0
Bites inflicted on head and face { Multiple	5 (5)	1 (2)	1 (1)
Cauterization { Efficacious	....	....	....
Cauterization { Non-efficacious	2	....	1
No cauterization	3	2	....
Bites inflicted on hands { Simple	21	13	4
Bites inflicted on hands { Multiple	9 (30)	19 (32)	4 (8)
Cauterization { Efficacious	1	1	....
Cauterization { Non-efficacious	11	16	3
No cauterization	18	15	5
Bites inflicted on limbs and body { Simple	5	4	6
Bites inflicted on limbs and body { Multiple	2 (7)	4 (8)	(6)
Cauterization { Efficacious	....	1	2
Cauterization { Non-efficacious	4	2	1
No cauterization	3	5	3
Clothes torn	2	3	....
Bites inflicted on bare parts	5	1	1
Bites on different parts of body	...5	....	....
Cauterization { Efficacious	1	....	....
Cauterization { Non-efficacious	1	....	....
No cauterization	3	....	....
General total, 104.	47	42	15

The column A refers to persons bitten by animals in which hydrophobia had been evidenced by experimentation, or by death of some other persons or animals bitten by them; column B to persons who had been wounded by animals recognized as rabid by the clinical or veterinary examination; and column C to cases in which hydrophobia could only be suspected, as the animals had disappeared or were killed instantly and their bodies thrown away.

No death has been reported among these 104 persons, treated in 1892.

It will be of interest to those who may desire to follow up the history of these cases, to know from what localities the persons came, as follows:—

2 Alabama.	1 Michigan.	2 Ohio.
13 Connecticut.	1 Mississippi.	2 Pennsylvania.
2 Iowa.	2 Missouri.	1 South Carolina.
1 Louisiana.	40 New Jersey.	3 Tennessee.
4 Maryland.	7 New York.	2 Texas.
5 Massachusetts.	2 North Carolina.	14 Virginia.

The following statistics of various Institutes on the principle of the Pasteur Institute in Paris, which have a historic value in the records of inoculation, are given by Dr. Paul Gibier[1]:—

In St. Petersburg 484 people were vaccinated from July, 1886, to September, 1888, with a mortality of 2.68 per cent.

In Odessa 324 persons were vaccinated in 1886 by the primitive method, with a mortality of 3.39 per cent. But in 1887 and 1888, 709 persons submitted to the intensive treatment, and the mortality was reduced to 0.60 per cent.

In Moscow the Institute received 107 persons in 1886, who were subjected to primitive vaccination with a mortality of 8.40 per cent. But having adopted the intensive treatment in 1887 and 1888, 526 persons were subjected to it, with a mortality of only 1.45 per cent.

In Warsaw, out of 370 people treated by the new method, not a single death occurred.

In Milan 335 were inoculated; deaths, 0.60 per cent.

In Palermo 109 inoculated; no deaths.

In Naples 246 inoculated; mortality, 1.5 per cent.

In Havana 170 were bitten and inoculated, and the mortality was only 0.60 per cent.

In Rio de Janeiro, where Dom Pedro II. founded a splendid Institute, 53 were inoculated within a short time without a single death.

It is stated by Gibier that England has been one of the chief subscribers to the Pasteur Institute of Paris, where a number of British subjects are daily cared for. He refers also to the report of Mr. V. Horsley, the eminent physiologist, who in the name of an official commission composed of the principal scientists of England (among them Sir James Paget), recently declared that "M. Pasteur had discovered a method preventive of rabies, that was comparable to vaccination against variola."

The technique of the successive operations required for the preparation of the anti-rabic virus is as follows: The vaccinal matter consists of fragments of the spinal cord of a rabbit killed by hydrophobia, which are progressively desiccated at a fixed temperature, and in the dark. Every day a fragment of this substance is injected, but every time a less dried specimen is employed, being nearer to the virulent state.

The introduction of the active principles of the cords of rabid animals into the peritoneal sacs of rabbits, was found by Colli to produce rabies in from ten to twenty days. The period of incubation in dogs varies, and a report of the cases of six dogs bitten by a rabid animal gave the period of development as twenty-three, fifty-six, sixty-seven, eighty-eight, one hundred and fifty-five, and one hundred and eighty-three days respectively.

[1] The North American Review, August, 1890. The Pasteur Treatment, p. 163.

In human beings, statistics show that in sixty per cent. the period of incubation varied from eighteen to sixty days, while in thirty-four per cent. the period exceeded two months. In some cases the outbreak occurred from three to six months, and in others from one to two years, after the bite. Incubation in six per cent. extended from three to eighteen days only. It is estimated that forty-seven per cent. of persons bitten by mad dogs develop hydrophobia.

According to Youatt, two-thirds of the dogs bitten by rabid animals become affected; while Hertwig found that only six, out of one hundred and thirty-seven dogs bitten, died from the disease. Renault declares that he could only impart the disease by inoculation in sixty-seven per cent. of dogs so treated.

Of 796 human beings affected with hydrophobia in France, Wurtemberg, and Milan, 715 were bitten by dogs, 30 by cats, 31 by wolves, 19 by foxes, and 1 by a cow.

Watson quotes 75 cases of human beings, in 40 of which the hand was bitten by rabid animals, in 15 the face, in 11 the leg, and in 9 the arm. Bollinger reports 495 cases, in which the wound in 53 per cent. occurred on the upper extremities, in 22 per cent. on the hands and face, in 22 per cent. on the feet, and in 3 per cent. on the body and scrotum. In wounds of the face, 90 per cent. are followed by hydrophobia, in those of the hands 63 per cent., in those of the lower extremities 28 per cent., and in those of the upper extremities 20 per cent.

The variability of the period of incubation is owing in part to the site of the wound, and an explanation is offered by Gibier for the shortness of incubation observed in wounds of the head and face, as well as its longer duration when the limbs, and especially the lower ones, have been bitten. He says that after the rabic virus has been deposited upon the tissues which have been lacerated by a bite, one of two things may take place: either the virus remains on the wound, or it is carried into the general circulation by some torn blood-vessel (commonly a vein). In the first case it may happen that the phagocytes destroy the microbes, and no rabies occurs; but more frequently, the germs coming into contact with torn nerves are developed within the central portion of these organs, and thence are propagated as far as the nervous centres. This, in his view, explains the long duration of some incubations; for the march of the virus, that is to say, the development of microbes, may take place at first, and then only in a minute nervous fibre, whose cells offer a more or less important resistance to the invading germs; and before being able to reach the medulla and cerebral centres, the journey's length must vary according to the distance from the inoculated spot to the medulla or the brain.

Gibier remarks that if the absorption takes place through a blood-vessel or a lymphatic, it is easily understood that the incubation will not be of much greater duration than in those cases in which, for experimental purposes, the rabic virus is injected into the veins of an animal. In this event the duration is independent of the situation of the wound. The incubation seldom lasts less than three weeks, and generally lasts much longer. It was the knowledge of this fact that suggested to Pasteur the idea, which has since proved so useful, that if one could render an animal refractory to rabies by means of injections of attenuated virus, it might doubtless be possible to produce this

very state during the interval which separates the time of biting from that of invasion.

There has appeared upon the scene another claimant, not only as a prophylactic but as a curative process, in the action of gastric juice upon the cords of infected rabbits, as proposed originally by Eusebio Valli, and since adopted by Centanni. The emulsion, thus prepared, is said to arrest the progress of rabies in rabbits which have been under its influence for six days, while animals subjected to the operation of the same virus without its antidotal effect die within seventeen to eighteen days. Tizzoni and Centanni concluded from their experiments that the disease already developed in rabbits was cured by inoculation with this matter; and the inference drawn from these results encourages a resort to this injection in human beings who have been bitten by mad dogs or other rabid animals, and who have already the premonitory symptoms of hydrophobia. It is held to be not simply protective, but to be curative in its action.

My personal observation extends to three cases of hydrophobia treated in Brazil, during my residence in that country, and I am able to add to these the report made of a case in this country, since returning, which I was called upon to investigate by Mr. Henry W. Grady for the Atlanta Constitution.

The first case occurred in the person of a white boy, eight years old, at the City of Campinas, in the province of San Paulo, Brazil. He was bitten by a dog, which presented all the characteristics of rabies, on the 28th of June, 1882, and was brought to my office shortly afterward, with the blood still oozing from the tooth-wounds upon his leg. After washing thoroughly the parts, I gave directions to have each of the openings and the abrasions of the skin well cauterized with strong nitric acid. The father of the boy was then instructed to await developments, and in the event of further trouble to let me know promptly of any disturbances.

On the last day of August, sixty-four days after the bite was inflicted, I was called at 4 A.M., with the statement that the boy had been nauseated, with retching, on the previous day, but had been unable to bring up anything. My son, Dr. T. D. Gaston, was dispatched at once to see the patient, and finding him in a state of great agitation and restlessness, he administered by inhalation, at short intervals, four ounces of chloroform, before any material relief was afforded. I saw him with my son at 10 A.M., and found the boy writhing with spasmodic contractions of almost every muscle of his body, and constant convulsive movements of the arms and legs, with hideous contortions of his face. He would cry out as if in great pain, when the spasm was intensified, and spring up in the bed, spitting from the mouth foam mixed with blood. While his mental faculties were greatly excited, he was not delirious, but seemed conscious of passing events, and answered questions understandingly as to his sensations. Upon giving him a cup with water, there was an aggravation of the convulsive movements, and yet he attempted to drink without the ability to swallow. The cup, being seized with his hands, was turned up, so as to spill out the water from his lips; and yet none of it went down his throat.

Morphine having been given without effect, the use of garlic was resorted to internally and externally, as I had read an account of a man with hydrophobia having been shut up in a room where, suspended on the walls, was a quantity of garlic, which was ravenously eaten with salutary result. This boy ate the garlic freely, and even asked for more when the first portion was consumed. It was beaten up also and applied over his chest and bowels in the form of poultices, while a decoction of the garlic was used as an enema.

At 1 P.M. I took Dr. Melchert to see the patient, and found the spasm increased, with aggravation of all his sufferings. We resorted to inhalations of nitrite of amyl in doses of 15 drops every five or ten minutes for more than an hour, the boy being held by his father, but it had no perceptible influence upon the irregular movements. His powers seemed to become exhausted by the violence of the paroxysms, and his pulse became so frequent and feeble that it could not be counted at the wrist. He died at 3.30 P.M., less than twenty-four hours from the onset of the disease.

It may be a matter of some interest in studying the surroundings of this case, to give the thermometric record of the day. The temperature of the atmosphere at 7 A.M. was 66° F.; at 2 P.M., 74° F., and at 9.15 P.M., 75° F. It was a clear and sunny day. The access of the disease was not therefore induced by anything unfavorable in the state of the weather.

The second case was brought to me from the country in the person of a mulatto boy of 16 years, with the history that he had been bitten about a month previously by a mad dog, and that he had been complaining of his head for twenty-four hours. He was then suffering from general disturbance of the nervous system, with inability to swallow fluids. There was not such marked spasm of the muscles as in the boy whose case has been reported above, yet the symptoms ran such a course as to impress me with the characteristic features of hydrophobia. He was given ten grains of calomel, followed in two hours by a tablespoonful of castor-oil and a teaspoonful of oil of turpentine. After the bowels had been moved freely, a hypodermic injection of sulphate of morphine, gr. $\frac{1}{2}$, and sulphate of atropine, gr. $\frac{1}{75}$, was administered. Frictions with oil of turpentine were employed over the spine and epigastric region at frequent intervals. Carbonate of ammonium and camphor water were given internally, while enemata of lac assafœtidæ were liberally used. My treatment was intended to be conservative, so that no harm should come from the remedies employed, and that the charge of killing the patient might not hold against me. It has been claimed that the desperate nature of this disease warrants the use of desperate means, and the most violent measures have in some instances been resorted to, even to the infliction of bites from venomous serpents, under the supposition of some antidotal influence. In this case, however, I determined to avoid all crucial medication, and left the patient to succumb to the violence of his disease rather than to the toxic properties of drugs. He died from exhaustion on the second day of treatment, being the third after his attack, and thirty-three days after he had been bitten by the rabid dog.

Here it may be noted that no attempt was made to cauterize the wounds, and that the period of incubation was only about one-half that observed in the case in which the nitric acid had been ordered, but perhaps not properly applied by the father of the boy.

The third case which came under my observation was that of a young white man, about twenty years old, who had felt uncomfortable for a day and a night before I was called, nervous twitching with occasional spasmodic contraction of the limbs having supervened during the morning. There were periodic exacerbations of a convulsive nature observed during my first visit, and upon inquiry, it was learned that the patient had been bitten on the ankle by a small dog about two years previously. Neither he nor his friends had suspected at the time that this was a rabid animal, and they did not know what had become of it.

The difficulty in swallowing water being notable, I made out the case as one of hydrophobia, and determined to rest my treatment upon frictions along the spine with camphorated oil of turpentine, and upon inhalations of ether, the use of which upon a towel, held over his mouth and nose, gave relief to the patient.

As to the final effects of the employment of the ether in this case, urged from time to time so as to control the violence of the paroxysms, nothing was observed which should give encouragement to its repetition in similar cases. Having experimented with chloroform at the outset of the first case, and afterward with the nitrite of amyl, and now having tested the influence of ether, without securing any satisfactory result, I should be inclined to try some other class of medication if another case of hydrophobia should come under my care.

The patient died on the morning after I first saw him, having had most violent paroxysms of irregular muscular contractions whenever the ether was temporarily withdrawn. There was no evidence of any curative agency from its use, though his sufferings were lessened, and only for euthanasia is its employment commendable.

While administering the ether, my forefinger was caught between the teeth of the patient, and was lacerated so that the blood flowed from it at a point on the inside, near the nail. The wound was immediately bathed in oil of turpentine, and sucked by myself most energetically, the finger being afterward enveloped in cotton saturated with turpentine. I had received the impression from writers on this disease as it occurs in man, that it was not communicable by the bites of human beings. But I considered that an abundance of caution in this case was called for, and hence acted promptly in preventing absorption by a firm grip around the finger with my other hand, until it had been washed with the oil of turpentine and thoroughly sucked. It gave me no concern afterward, and more especially as the bite had been inflicted through a fold of the towel held in the hand, did I feel relieved of all apprehensions. It has been proved since that the human virus may give the disease, and hence a bite should not be neglected.

In compliance with a request of Mr. H. W. Grady, as already mentioned, I made a visit to Social Circle in February, 1889, to get the facts connected with the death of a man in that neighborhood. It was reported currently that he had suffered from hydrophobia, and the object was to confirm or disprove that allegation.

Mr. J. H. W., a white man of middle age who lived on his farm, was bitten by a cat on January 2, 1889, the weather then being very cold. The wound was on his left front finger, where there had been a bone-felon in former years. He went on with his ordinary duties without seeming to be concerned about the injury, and the wound healed kindly before the end of the month. On February 2, there had been pain in the part, and on the following day he had had chilly sensations. During the 4th, 5th, and 6th of February there were developed well-marked convulsions, with dread of water and great difficulty in swallowing fluids, while froth came from his mouth.

On the third day of his disorder, he would be quiet a minute or two, and then a "spell" would come on and he would jump up and run around the room, saying afterward that he was choking to death. He could say nothing while the "spell" was on him.

He attempted on the morning of the 5th to take milk through a quill, and got a little in his mouth, but could not swallow it. In the evening, however, he ceased running and hitting himself on the breast to get breath, after which he was able to swallow, and drank several dippers of water. The "spells" still came on occasionally, but he seemed to be getting better for a time. But about midnight he changed for the worse again, and he would jump up three or four feet from the floor and beat himself with his fists. Those around him tried to hold him in bed, and he would clinch his jaws and grit his teeth, and gasp for breath. He died at 9 P.M. on Wednesday, February 6, after repeatedly

jumping up from the floor of the room in which he was kept under guard by his friends.

When the symptoms in this case are taken in connection with the fact that the patient had been bitten by a cat which exhibited a pugnacious disposition, there is a strong presumption in favor of the trouble having had its origin in the bite. The disorder developed in a month after the injury to the finger, and ran its course with paroxysms of nervous and muscular disturbance, terminating in death after four days of acute suffering. The spasm of the throat which prevented the swallowing of water or other fluids, the general excitement, the incessant movement of the limbs, increased by contact of currents of air with the body, and the frothing of the mouth in the later stages of his disturbance, render it clear that the patient labored under hydrophobia. It was evident that his mind was not deranged in a way to affect his appreciation of passing events, but he manifested a disposition to do many things of an extraordinary character, including an inclination to bite those who came in close proximity to him.

There were on those days exacerbations of the spasmodic movements, and his neck and face were disfigured by considerable swelling. He seemed impressed with a conviction that death was near at hand, but did not give any intimation that he was aware of the nature of his disease.

It may be stated that the cat was killed soon after biting this man, under the impression that it was suffering from rabies.

There were a number of instances reported by the people in the neighborhood, in which dogs and cats had gone mad and had been killed. Some persons had been bitten by these animals, but no other case of hydrophobia had occurred. The "mad-stone," so called, had been used in some of those bitten, but in others no sort of treatment had been employed.

There is found in the stomach of the deer a concretion of a porous nature, which has been applied to the wounds inflicted by mad dogs, under the designation of "*mad-stone*," and if it adheres to the part it is supposed that the poison is extracted. Any porous substance when moistened may, by capillary attraction, promote a discharge from a wounded surface to which it is applied, and it is claimed that the virus thus enters the interstices of the stone.

In the cases now under consideration, a solid mass taken from a horse's head, and hence inferred to be of an osseous nature, had been employed; but in other instances, when nothing of the kind had been used, the persons bitten escaped in like manner, without any serious consequences. It seems that substances derived from various sources have received the designation of "mad-stone," and among the common people have been accredited, but there is no proof of their efficacy.

With the light before us in regard to the efficacy of intensive inoculations during the period of incubation of hydrophobia, in the reduction of mortality to $\frac{1}{4}$ of 1 per cent., those bitten by rabid animals should of course avail themselves of the Pasteur treatment. But there are many instances among those who are not informed of their danger until the onset of the disease, for whom antidotal measures might avail, if a true antidote should be discovered. Having observed the controlling influence of large doses of bromide of potassium and hydrate of chloral in the treatment of traumatic tetanus, I should be inclined to push this line of medication to the uttermost tolerance of the patient, should another case of hydrophobia come under my care. Let others determine upon the course which seems most favorable for clinical experimen-

tation in this disease, and it is not beyond the range of probability that a trustworthy remedy for hydrophobia may yet be discovered.

In regard to the treatment of hydrophobia when the disease is actually present, there have been more definite results from the woorara than from any other of the many agents which have been employed. But the general principles of therapeutics have not availed for any definite rule of treatment other than to seek a corrective for the disordered nerve-centres. It is evident that no inference should be drawn in favor of the efficacy of measures applied during the period of incubation, as there is no sufficient ground, in most instances, to believe that the disease would have been developed. In view of the great fatality of cases in which hydrophobia has actually appeared, and of the very limited benefits derived from medication of any kind, there is open to the profession a wide field for experimentation on the canine species, to ascertain what course of treatment may prove efficacious in staying the lethal tendency at the earliest stage of the disease. In like manner heroic remedies should be tested early in the human subject by scientific investigation.

SCROFULA AND TUBERCULOSIS.

BY

F. FORCHHEIMER, M.D.,

PROFESSOR OF PHYSIOLOGY AND OF CLINICAL DISEASES OF CHILDREN IN THE MEDICAL COLLEGE OF OHIO, CINCINNATI, OHIO.

ETIOLOGY AND PATHOLOGY.

WITH the discovery of the cause of tuberculosis by Koch, in 1882, the whole subject has assumed a different aspect. The acceptance of the bacillus tuberculosis as the primary cause of all tubercular processes, it matters not as to their nature or their locality, has given us an entity which makes superfluous most of the theorizing for which this broad subject has been noted. The work of Koch in this direction has been so broad, so fundamental, and so thorough, that it has not been found necessary to take away from it or add to it one iota, and subsequent observers have been able to verify fully all that he has done. As a result of the labors of Koch and his followers, it can be truly said that there exists neither animal nor plant whose characteristics or properties are better understood by scientists than those of the bacillus tuberculosis. While admitting this, gratefully and freely, it must be as freely admitted that the chapter on human tuberculosis has by no means been written to its end. It seems strange to look upon a discovery made but eleven years ago as in the light of remote history, but so much has been done since that time that such a view is warrantable. In the justifiable enthusiasm of that period so much was done with the bacillus, and so little regard paid to the human being, that many conclusions were offered and accepted which, in the light of subsequent and cooler observation, had either to be amended or dropped; so that many over-cautious members of the profession were apt to look upon the whole subject of the bacillary origin of diseases with distrust. At the time of writing, however, the proofs originally required by Koch have been accepted as adequate, and the bacillus tuberculosis is universally looked upon as the cause of the tubercular process. Sufficient time has elapsed to test these views in practice, which is, after all, the best testimony as to the value of any discovery, so that one of the greatest achievements of science, in any age, can be attributed to this century.

The purely technical portion of the subject need not be discussed here; in these days it has become common property, and has been treated of in works especially devoted to bacteriology. The diagnostic value of the bacillus tuberculosis is established, and no practitioner considers his

diagnosis of a tuberculous process complete without a demonstration of the bacillus, which he can make for himself by methods well known and easily executed. The two etiological factors of the production of tuberculosis in the human being are the bacillus and predisposition. The bacillus is a parasitic plant, rarely saprophytic, and the human being, the ruminants, with rabbits, guinea-pigs, and other animals, are its hosts, and from these, by means of infection, the process is transmitted to others. This is done in one of a great many different ways, but the tubercle bacillus, or its spore, is always introduced into the healthy animal. The fact that the spores of the bacillus elude detection except by culture, gives rise to the possibility of deductions that may have to be revised in the future. Infection of the human being takes place either by way of a mucous membrane, from a lesion of the skin, or during intrauterine life, from either the male or the female. The hereditary form of tuberculosis has been a subject fruitful of discussion. In the early days of the discovery of the bacillus, heredity as a factor in the production of tuberculosis was almost swept away. Notwithstanding the accumulated evidence of ages, the adherents of the bacillary nature of the disease felt themselves constrained to deny the existence of hereditary tuberculosis; the fact that the bacillus could be transmitted from parent to offspring did not enter into their calculations as an additional evidence of the important *rôle* which it played. At the present day, Galtier has proven the existence of congenital tuberculosis experimentally, and observations by Lucas, Schmorl and Birch-Hirschfeld, Baumgarten, Landouzy, McFadyean and others, make it imperative to accept this form of tuberculosis. In these cases the bacilli or their spores pass through the membranes of the placenta, and infection of the fruit takes place.

The mucous membrane may become infected either by inhalation of the tubercle bacillus (respiratory tract), by the swallowing of infected food (gastro-intestinal tract), or by direct contact with the bacillus in other ways. The mode of infection seems to vary with age; in children we find the intestinal tract with its adnexa most commonly affected, in adults it is the respiratory tract. Milk is the most common carrier of infection for children; for adults it is the breathing in of dried tubercle bacilli.

The fact that not all who breathe or swallow tubercle bacilli, probably not the majority, become tubercular, and certain other facts, have led to the reacceptance of the idea of predisposition. When an enthusiast (Cornet) says that the human being is just as much predisposed to becoming infected by the tubercle bacillus as a soldier in battle is predisposed to being struck by a bullet, it marks a period in bacillary literature characterized by acceptance of laboratory facts, regardless of clinical experience and medical tradition. As there are animals immune to the tubercle bacillus, so there are doubtless human beings in whom it would be impossible to cause the tubercle bacillus to grow. Predisposition is of two kinds: permanent and temporary. The first inherited, congenital, or dependent upon some peculiarity of structural or metabolic function not definable at the present time; the second usually produced by some disease, whooping cough, measles, syphilis, or, locally, by some inflammatory lesion. Again, there may be a local or a general predisposition; the local predisposition is probably most

common, certain tissues, as bone and glands, being most remarkable in this respect. In some human beings tuberculosis may remain localized for a life-time, and yet, as has been shown in the treatment of lupus by tuberculin, a general predisposition may be created which may cause the patient to lose his life by the invasion of vital organs.

Attempts are being made in civilized countries to prevent the spread of tuberculosis; this has been done as the result both of private and of state initiative. While it is, as yet, too early to speak of results, the next ten years must certainly show whether or not we are on the right track. From a purely theoretical standpoint, prophylaxis may be obtained in two distinct ways—first, by preventing the contact of the bacillus with human beings; secondly, by making its contact harmless. As yet we are engaged with the solution of the first method. It has been the object to prevent contact by hunting up the source whence bacilli come, and then removing this source. It is needless to say that much has been insisted upon, in this direction, that will be deemed unnecessary in the future. Many suggestions have been made that, while perfectly just, are nevertheless absolutely impracticable: to change the breed of cows, to give up drinking milk or eating butter, etc., etc. As we know the sources whence tubercle bacilli come, all that seems necessary would be a careful control of these sources; unfortunately, this is an undertaking of enormous magnitude, involving many questions, and not likely to be completed in the present condition of civilization. It involves competent inspection of food, scientific observation of cows supplying milk, and, lastly, the treatment of individuals affected with tuberculosis, as a source of infection. It is unnecessary to dwell upon the latter feature; it will certainly require much dissemination of knowledge before this can be accomplished, and when it has been accomplished, let us hope that it will have been done in a manner less cruel and inhuman than seems necessary according to the directions insisted upon by extreme enthusiasts. The sober discussion by learned societies of the question, "Should phthisical patients be allowed to marry?" although not new, shows the trend of modern opinion. At the same time it shows the Utopian plans of these purely theoretical people. When the time comes in which the proper authority can determine the breeding of human beings, the days of physical perfection will be at hand. The other method, that of rendering the tubercle bacillus innocuous, would seem more feasible in all directions. The tubercle bacillus is not ubiquitous, but comes from sources rather well known; for the present it seems more practicable to diffuse knowledge in this direction, and to do so is evidently the duty of every practitioner, however humble his station.

For *scrofula*, matters are very much more unsettled than for tuberculosis. The statement can be made without fear of contradiction that most cases of scrofula are really cases of tuberculosis; this has been proven by investigation both clinical and otherwise, and by the application of this view to therapy; indeed, many processes in glands and bones, formerly called scrofulous, are now unhesitatingly pronounced tuberculous, and can be proven such by careful examination. But there are a good many patients in regard to whom it would certainly be wrong to speak of tuberculosis; the utmost that would be warrantable would be to say that these have a tendency to tuberculo-

sis, that they are predisposed to tuberculosis. To this class belongs that large number in which we find a certain vulnerability of tissue with accompanying enlargement of lymph glands; in which the least irritant will produce an inflammation characterized by chronicity and lack of tendency to *restitutio ad integrum*. While the uncertainty of the nature of the process in this number must be continually reduced with increased research as to etiology, there will, of necessity, be left a certain portion in which the cause must be sought for within the individual. Here again, we shall find a local as well as a general predisposition; enlarged lymphatics predispose to those processes called scrofulous, impeded lymph-circulation will render tissues more vulnerable, it matters not whether enlarged lymphatics are produced by local or general causes; a tubercular gland will therefore be a cause for so-called scrofula. A step farther will bring us to the conclusion that glands enlarged as a result of any cause, as simple as the presence of pediculi capitis, may act in the same manner. On the other hand, any general cause producing enlarged lymphatics will be followed by the same effects; tuberculosis, syphilis, the acute exanthemata, notably measles. If, then, we were to define scrofula as tuberculosis, we should be overshooting the mark, as in many cases we have no evidence that such is the case, or that there ever will be tuberculosis. But, on the other hand, if this is not accepted, there remains no definition except that of a predisposition to many things, including tuberculosis. A careful view of the history of scrofula will show that many things were formerly accepted as scrofula which, with the advance of science, have been proven to be due to other causes. Where formerly whole books (Lugol, Scharlau, Hufeland, Glover, Kortum, and others) were written upon scrofula, the subject can at the present time be satisfactorily dealt with in a chapter. The question naturally arises, Are we justified in making a diagnosis of a predisposition? Can such a diagnosis be put upon a scientific basis? It certainly seems as if both questions should be answered in the negative. The diagnosis is not even one that is necessary; it is an obstacle to searching for the true cause of the condition; it therefore prevents investigation and does the patient harm in that it is in the way of causal therapy. For the present, it is suggested that scrofula be dropped from our nosological table, to be reinstated when we can come to some definite knowledge regarding its entity.

In this connection, as well as in regard to the whole subject of tuberculosis, it is of paramount importance to decide whether tuberculosis is constituted by the presence of the bacillus, or by the production of lesions by the bacillus, or by both together. It is a self-evident proposition that bacilli may be found without tuberculosis. It is not so easy to decide whether lesions may be found, tubercular in nature, in which the bacillus or even its spores may have disappeared, or may not be proven to be present by inoculation or culture. The prebacillary pathological definition of tuberculosis is no longer accepted, but it seems necessary to make a new definition which will include all those changes that may be due to the bacillus tuberculosis. For scrofula it has been pretty accurately determined that all the lesions, with the exception of those of the skin and mucous membranes, are usually due to tuberculosis. Some experimenters, however, have failed to produce tuberculosis by inoculating with scrofulous glands, and, as yet, it is too early to decide

the question without the aid of pathological anatomy, a neglect of which is already beginning to show itself among the tendencies of the ardent followers of bacteria and immunities.

TREATMENT.

Next to the discovery of the bacillus, the *treatment* of tuberculosis has enjoyed the attention of the whole medical world more than any other division of the subject. The fundamental work of Koch had been so thoroughly done and so thoroughly accepted that when, at the tenth meeting of the International Congress at Berlin (1890), he intimated that he had found a remedy for tuberculosis, every physician considered the whole matter more than half solved. This attitude was, however, quickly changed to expectancy by Koch's first publication, which took place simultaneously in England, Germany, and the United States—so eager was every one to obtain details of the good news. The claims that Koch made for his remedy, afterward called tuberculin, were (1) That it made animals immune to tuberculosis and cured animals ill with tuberculosis; (2) That it was a diagnostic remedy absolutely essential; (3) That it was curative. Koch does not describe the method of obtaining the remedy, a procedure in which he is unfortunately upheld by some of the best German authorities, and one which cannot be too strongly condemned; but he tells where the remedy can be obtained, and advises the use of a new hypodermic syringe which is as cumbersome as it is unnecessary. Tuberculin, he claims, causes a specific effect upon tubercular processes; the diseased tissue is killed and is detached as a dead mass, or is fluidified; the bacilli are not killed, but the tissue surrounding them is affected. The diagnostic effect is observed in the form of a reaction, consisting essentially in a decided rise in temperature, accompanied by *malaise*, cough, vomiting, difficulty in breathing, preceded by a chill—one or more of these symptoms—but always the rise in temperature. For lupus, and for tuberculosis of glands, bones, and joints, he promises "rapid cure in fresh and mild cases, slowly progressive improvement in severe cases." In phthisis there is to be, first, increase in cough and expectoration, then diminution and disappearance of these symptoms as well as of the bacilli. "Incipient phthisis can be cured with certainty by means of the remedy;" relapses are unimportant, as they also can be cured. Only where there are large cavities can little be expected. With all this promised by a man of Koch's scientific reputation and trustworthiness, it is not to be wondered at that Berlin was looked upon as a Mecca, that both physicians and patients flocked there from all parts of the world, that scientific societies were dragged into enthusiastic utterances,[1] and that even German-hating Frenchmen like Pasteur were converted (*il y a, il n'y a pas à discuter*). In this period of enthusiasm every one, with few exceptions, was for the remedy; the subject was taken up by the German government, the Reichstag was interpellated (Dr. Graf): "What will the government do to get the remedy and make it of service to Germany, if necessary to the whole world?" At the same time the lay press was doing its best to obtain every sensational element out of the situation, being assisted

[1] Freie Vereinigung der Chirurgen Berlin's, 16 Nov., 1890.

therein by ambitious medical individuals, and what with the government, Koch and his followers, the patients, the doctors, and the medical and lay press, there ensued a period such as has never been seen before in medical history, but which resulted in a large number of experiments on human beings which must bring a certain amount of knowledge.

During this period objections were raised to tuberculin by Leyden, Kaposi, Arloing, and Goldschmidt, as to its diagnostic value; Henoch and Litten warned against its use in tubercular meningitis; Ewald saw physical evidences of consolidation and even of cavities appear, and spoke of a death after injecting gm. 0.0002 in a case of lupus from disseminated catarrhal pneumonia in both lungs; Paul Guttmann stated that hæmoptysis was a temporary contra-indication, but there were men of very good reputation who did not hesitate to speak of results after having used the remedy for three weeks. Thus did the printed matter increase, every country possessing its own Koch disciples and enthusiasts, until there seemed to be no end to tuberculin literature. It was left to the master-mind of Virchow to bring some order into this chaos, and, at the same time, to check the ever-increasing number of human experiments, by his authoritative statement from the post-mortem room. About three months after Koch's first publication, Virchow made the following statements about tuberculin: It produced enormous hyperæmia; hemorrhage (one case died of hæmoptysis from an old cavity); positive inflammation, especially at the edges of ulcerations and in the lymphatic glands (leucocytosis); œdema of the glottis, and phlegmonous retropharyngitis. In the lungs it might be followed by caseous hepatization and phlegmonous catarrhal pneumonia, in all probability by fresh sub-miliary tuberculosis, which was not affected by the remedy. Again, all tubercles were not affected; those that were might give up their bacilli, producing secondary infection. He warned against the use of tuberculin, especially in ulcerative processes. This statement marked, as it were, the end of the period of enthusiasm, only interrupted by the second communication of Koch. In this communication Koch reported cures and repeated the claims of his first article. He now gave some information regarding the nature of tuberculin; it was a glycerin extract of tubercle pure cultures; the active substance could be precipitated by alcohol, but was not a toxalbumin, as it withstood high temperatures and could be dialyzed; about one-fourth per cent. of this was contained in tuberculin.

We now come to the discussion of the second period in the history of this remarkable remedy; one in which sober thought, careful investigation, and criticism, took the place of blind faith and thoughtless following of a great leader. In this second period not a single claim which Koch made in his first paper remained unchallenged, so that the query arises why Koch should have published as he did, and then have followed up his first publication by a second one amplifying the first and maintaining its supposed truths. Rumors of various sorts have been spread explaining the prematurity of publication; much may be done to rehabilitate the confidence, now lost, in Koch, yet the fact remains that the medical profession of the world has been reduced from a condition of joy and happiness in the discovery of a remedy for tuberculosis, to one of distrust and disappointment, much to the detriment of other discoveries that may be made. The effect upon the public has been

incalculable as to the lack of confidence, natural to them, in the powers of medicine; but this will pass away in a comparatively short time, leaving those physicians who were not pulled along with enthusiasm, to share the humiliation with those who are in the habit of shouting loudest upon the least provocation.

First, as to the prevention of tuberculosis in animals treated with tuberculin: all observers have shown that non-infected tissues may become tubercular during treatment, and that, in the rabbit, tuberculosis is not cured by the remedy (Baumgarten, Arloing, Rodet and Conomont, Popoff, Pfuhl, Gasparini and Mercati, Donitz, Ernst, Trudeau).

Next, as to the chemical structure of tuberculin, Koch says that the active principle is not a toxalbumin; William Hunter has made a careful study of the fluid, and finds that it is made up of the following substances: (1) Albumoses—principally proto- and deutero-albumose, less hetero-albumose and, occasionally, traces of dys-albumose; (2) Alkaloidal substances, two of which can be obtained in the form of "hydrochlorate salts" of platinum compounds; (3) Extractives; (4) Mucin; (5) Inorganic salts; (6) Glycerin and coloring matter.

He has succeeded in forming four modifications of the active principle, all of which have to a greater or less degree one or more of the effects of tuberculin, and he finally comes to the following conclusions:

Tuberculin owes its activity to at least three principles.

Fever is absolutely unessential to its remedial action. Inflammation, too, is unnecessary, although it sometimes helps therapeutic action.

The remedial substance and albumoses probably belong to the proteins, *i.e.*, substances extracted from bacteria.

To this most excellent observer[1] do we owe our knowledge of the chemical structure of tuberculin, expressed in terms conforming to our present knowledge of the albumins. If to this there be added the fact first pointed out by Korczynski, that all samples of tuberculin are not the same, the criticism may justly be offered from a scientific standpoint that pharmaceutical accuracy can hardly have been complied with when injections of tuberculin were made, and that empiricism was being indulged in, since it was impossible to state which cause produced the given effect.

If we now examine the "specific effect upon tubercular processes" (Koch), as described before, many interesting things are found. That there is no specific effect has been shown by Roemer and verified by Buchner, in that chemical extracts from bacillus pyocyaneus and bacillus pneumoniæ produce, practically, the same results as tuberculin. The changes themselves can be best summed up as has been done by Virchow, who shows that the remedy has very little effect upon tubercles, and that tubercles of mucous membranes seem to degenerate more rapidly after its use, producing ulcers, the diseased tissue not being destroyed. Greater changes are observed in the surrounding tissue, necrosis being produced and resulting in the enlargement of cavities and in the perforation of intestinal ulcers. Ulcers, themselves, are cleaned.

As regards its curative influence, Kluge and Burci have shown that tuberculin produces a positive chemotactive effect; Gaertner and Roemer (chemical extract of tubercle bacilli) that it is a lymphagogue. In

[1] British Med. Journal, July 25, 1891.

this way can the remarkable changes which follow the use of tuberculin be partially explained: the leucocytoses, the œdema in various parts, the necrosis, possibly the inflammations.

In this connection it is well to take up the views of Klebs, who says —not being in accord with any other observer—that tuberculin produces two distinct effects upon bacilli: their destruction, and a retardation in their growth. The action upon bacilli is without necrosis, but is a metaplastic one, due to a moderate infiltration of white corpuscles and fluid. He claims that there are two classes of substances in tuberculin: one deleterious, producing necrosis and inflammation, the other destroying the bacilli; he has isolated the latter, and calls the substance tuberculocidin.

The diagnostic value of the remedy has been assailed almost from the beginning, when Leyden expressed his doubts in the matter; this was quickly followed up by the statement that patients with lepra (Kaposi, Arloing, Goldschmidt) and ulcer of the stomach (Oppenheim) did react, and that several with well-marked tuberculosis did not (Bardeleben, Israel—case of lupus). It was also established that perfectly healthy individuals might react with small doses (Korczynski and Adamkiewicz), so that Leyden, in a later communication, felt himself warranted in saying that the practical diagnostic value of tuberculin was very limited, and that he had never had any assistance in diagnosis from its use. It is now used by veterinary surgeons, and Eber, collecting a large number of cases from various sources, shows that it is diagnostic in over 84 per cent., which might make it valuable for cows, but hardly for human beings. All who have used tuberculin agree that, even for diagnostic purposes, its use is not devoid of danger; Henoch and Korte will not use it in tubercular meningitis, Henoch warns against employing it in children, and many deaths are reported as resulting from its use. It is Virchow, again, who sums up its deleterious effects as: *a*, very great fluxionary hyperæmia and œdema; *b*, hemorrhagic processes; *c*, very intense inflammatory processes, especially in the lungs; *d*, second eruptions of new and sub-miliary tubercles.

In discussing the curative effects of any remedy in tuberculosis, much caution is required, in that we must not lose sight of the fact that a great many cases are cured spontaneously, or at least without the intervention of any remedy for which specific properties can be claimed. This is especially the case with phthisis, where so many patients have been cured by means of acting upon the individual as a whole; change of occupation, surroundings, climate, nutrition, etc. The great number of publications during the early period of the use of tuberculin can be disregarded entirely, because they simply show that phthisical patients have been benefited, as they would have been, and have been, by any remedy producing the great psychical effect that was produced by tuberculin. To verify this statement it is only necessary to look through the literature of the treatment of phthisis pulmonalis, and to see the great number of remedies that have been successfully used. More was promised in the treatment of local tuberculosis—lupus, and tuberculosis of the larynx—in which the astounding changes that take place in the tuberculous processes can be observed. While there could be no doubt concerning these changes, the question of cure could only be decided upon as a result of observation extended over a greater length of time

than had been employed in the beginning. For surgical tuberculosis, König and Bergmann said early that they had seen no cures; Virchow, that not a single case of any form of tuberculosis had been cured; Ewald was not sure but that the same good results would have followed any other form of treatment; Koehler declared that not a single case of lupus could be cured.

The present state of opinion as to the tuberculin treatment can be best illustrated by a discussion in Berlin in connection with a paper read by Thorner.[1] Leyden does not wish a new era of tuberculin treatment to be inaugurated; he has ceased using tuberculin, which is not a reliable diagnostic remedy, even veterinary diagnoses being problematic, though these need not be as exact as in the human being, and therefore are not as important. He has had no therapeutic results; even in tuberculosis of the larynx only one case has been cured, and this would probably have recovered without the use of tuberculin. "I consider it perfectly correct that tuberculin should be dropped in the treatment of tuberculosis, and that its careful application should be permitted only now and then." Ewald says that the end of the tuberculin period has been marked by the use of very small doses. Tuberculin has no specific effect upon tuberculosis, and therefore it has been given up by the great majority of German physicians.

As it is in Germany, so it is everywhere; tuberculin has been tried and found wanting; its history has been described as occurring in Berlin; as it was in Berlin so it was everywhere, as it is in Berlin so it is everywhere. There are still those who use tuberculin; they are in the small minority, but their number will not diminish until something new and more promising shall have been brought out. After Hunter's work it is difficult to conceive how any one can still use the original fluid; but how some of his bodies (B and CB) may appeal to a physician can be readily understood, and an outcome from the tuberculin treatment may still be possible. If this should be the case it must surely come from the direction first followed by Hunter; the original fluid, the *tuberculinum depuratum*, and tuberculocidin, are certainly things of the past, and mark an epoch in medical history as instructive as, up to the present day, it has been without practical value or compensation.

Following close upon the use of tuberculin came Liebreich's treatment by means of the cantharidates, good results being reported by various observers (Heyman, B. Frankel), and then Tranjen's with thymoloacetate of mercury—both, however, meeting with very little favor and, apparently, being soon dropped by the profession.

More recently, in connection with the modern ideas of serum-therapy for the purpose of immunization, dog and kid serum have been injected into human beings, and again excellent results have been reported. It would seem, however, that, in this connection, little can be hoped for in the treatment of tuberculosis, since the human being does not become immune to the tubercle bacillus.

Indeed, it seems that the greater the number of tubercles present in the human being, the more likelihood of an increase. But we are anxiously awaiting clinical testimony on the subject of serum-therapy in other diseases, and it may become possible to render a human being

[1] Deutsche med. Wochenschrift, 14 Sept., 1893.

immune to tuberculosis by artificial means, where internal immunization is not accomplished.

While this article does not claim completeness in even mentioning all the remedies used for treatment since the previous volumes of this work appeared, it would be dereliction not to mention two remedies which have been accepted quite universally, creasote and iodoform.

Creasote was first used by Bouchard and Gimbert in 1877 for the treatment of tuberculosis, and was reintroduced by Fräntzel and Sommerbrod in 1887. The latter has made a "method" of the treatment in that he uses enormous doses, from 1 to 4 grammes daily, combined with cod-liver oil. It has been conclusively proven that creasote exerts no influence upon the bacilli; it must therefore act indirectly, possibly by influencing metabolic processes so that general nutrition is improved. It has been especially recommended in the treatment of phthisis pulmonalis and the so-called scrofulous processes. Even upon this subject do we find quite an extensive literature, and the evidence seems to be favorable to this method. It has seemed to me that the large doses of creasote are unnecessary; small doses of creasote with large doses of cod-liver oil do just as well. Care must be taken to have good specimens of both remedies. The active principle of creasote, the so-called guaiacol, has also been extensively used; after the statements of Kobert, and in view of Wyss's case of fatal poisoning by its employment, it may be found very advisable to limit its dose.

Iodoform has been especially used in surgical tuberculosis, and with the best results, being injected into the affected parts in suspension. It has also been given internally in gastro-intestinal tuberculosis. The action of iodoform upon tubercle is not understood; it kills the bacillus in from two to three weeks, when in suspension (Troje and Tangl); but simultaneous introduction of iodoform and tubercle bacilli into an animal has resulted in tuberculosis (Baumgarten, Kunz, Rodzing), and experimental tuberculous abscesses are not cured in animals, as they are in man. Views vary as to the nature of its effect, whether upon the bacilli or upon the tissue, but all writers seem inclined to believe in the beneficial effects of the drug.

The tendency to spontaneous cure of tuberculous processes, where the tissue is given the proper opportunity, has been abundantly proven by surgeons. Complete rest of a tubercular joint, which forms the basis of nearly all orthopædic procedures in joint disease, with proper attention to the general condition of the patient, shows that without active interference tuberculosis can get well.

The same has been, in a measure, proven for the treatment of the internal organs; up to the present time, all those remedies which attack the tubercle or its surroundings have proven failures; the best results are obtained by acting indirectly upon the process. Even the brilliant results obtained in tuberculosis of serous membranes, by opening the cavity and exposing it to the air, cannot be looked upon as contradicting this statement.

RACHITIS.

BY

J. LEWIS SMITH, M.D.,

CLINICAL PROFESSOR OF DISEASES OF CHILDREN IN THE BELLEVUE HOSPITAL MEDICAL COLLEGE, NEW YORK.

RACHITIS is a constitutional disease, but its most conspicuous anatomical characters pertain to the osseous system. The gross nutritive changes which it produces in the bones and cartilages, causing deformities, are well known to both physicians and public. In addition to these anatomical changes in the skeleton, typical cases exhibit a lack of tonicity along with stretching of the ligaments, causing the knock-knee and flat foot. They exhibit also weakness of the muscles, resembling paralysis, and sometimes mistaken for it in severe cases, reflex irritability, rendering rachitic patients liable to laryngismus and tetany, undue perspiration, anæmia, and proneness to catarrhal inflammations. Certain anatomical changes in the spleen and liver also occur in aggravated forms of the disease. These many and diverse anatomical and functional characters indicate the constitutional or general nature of rachitis. Therefore theories which restrict rickets to the osseous system are inadequate and erroneous.

ANTIQUITY OF RACHITIS.—Rachitis is probably an ancient disease. It is said that an old statue of Æsop, who was thrown from a precipice by the indignant Delphians 564 years before Christ, exhibited rachitic deformities; and Hippocrates, born 460 years before Christ, is believed to have alluded to this affection in his Treatise on the Articulations.

Occasional expressions in the works of Celsus and Galen in the second century of the Christian era have led writers on rickets to believe that they also had observed the deformities produced by this disease. But rickets was first investigated in a scientific manner by Whistler, Glisson, and their contemporaries in the middle of the seventeenth century. During the last few years many excellent monographs have been written on rachitis, and its causation, pathology, and treatment are better understood than formerly.

FREQUENCY.—Rachitis is widespread, but it is comparatively infrequent in rural localities where families enjoy the hygienic requirements of pure air, sunlight, and a plentiful diet of good quality. It is most common in the crowded and badly fed families of the city tenement-houses where anti-hygienic conditions prevail. As pointed out in Vol. I., mild cases of rickets, not manifested by any prominent signs or

symptoms, are often overlooked, so that the physician is not summoned, or, if he be summoned, and have not given particular attention to this disease, he, in not a few instances, does not detect its presence. In the absence of deformity which occurs late, the fretfulness, tenderness of surface, and perspiration, are likely to be attributed to other causes than the correct one. Hence, according to my observation, rachitis is more common in its milder forms in the asylums, dispensaries, and tenement houses of New York, and probably in other American cities, than is commonly believed by the public, and even by physicians who have given little attention to the disease.

A few years since, in one of the New York asylums, my attention was directed to a rachitic child in whom the anatomical changes of rachitis had become so pronou ced that they attracted the attention of the nurses. Prompted by the occurrence of this case, which had developed during my attendance in the asylum, I made an examination of all the infants, and found, what I had previously not suspected, that about one in nine presented unmistakable signs of rachitis, though in a mild form and for the most part in its commencement. The late Dr. John S. Parry, of Philadelphia, stated that at least 28 per cent. of all the children, between the ages of one month and five years, who came under his observation in the Philadelphia Hospital during the three years preceding the publication of his paper in 1872, were rachitic.[1] According to Dr. Gee, whose observations were, however, made as far back as 1867 and 1868, of the patients under the age of two years in the London Hospital for sick children, 30.3 per cent. were rachitic; and Ritter von Rittershain, whose observations were also made several years ago, declared that of 1623 out-door patients under the age of five years brought to the clinic at Prague, 504, or 31.1 per cent., manifested this disease. Recently Professor Henoch, of the University of Berlin, has stated that he has seen many thousand cases of rachitis, and he adds that its spread in the large cities of Northern and Middle Europe is enormous. He says that his observations in regard to the frequency of rachitis in dispensary practice correspond with those of Ritter, as many as 31 per cent. being rachitic.[2] In Manchester, also, with its large number of operatives, Ritchie's statistics show that of 728 outdoor patients 219 were rachitic.[3] The curator of the New York Foundling Asylum for the last ten years informs me that he believes, but without the accuracy of statistics, that as many as 20 per cent. of the cases examined by him in the dead-house have presented the anatomical characters of rachitis, though usually in a mild form.

The recent large immigration from Europe of destitute families, living from choice or necessity in filth and degradation, who for the most part remain in the cities, occupying small, dark, and dirty apartments, and whose food is of the poorest quality and often insufficient, greatly increases the number of rachitic children in New York and probably in other American cities. In the outdoor department of Bellevue Hospital, to which many thousand immigrants from the lowest class of European society carry their sick children for treatment, rachitis is frequent, and the fact has been observed in this institution that a larger proportion of severe cases, attended by marked deformities, occurs in the Italian families than in those from other parts of Europe. In families of American parentage it is generally admitted that rachitis is more prevalent in the negro than in the white race.

[1] Amer. Jour. of Med. Sci., January and April, 1872.
[2] Vorlesungen über Kinderkrankeiten. Berlin, 1892.
[3] Medical Times and Gazette.

Although this disease occurs most frequently in the families of the destitute and poorly fed, nevertheless children of well-to-do families occasionally suffer from it, even in an aggravated form, in consequence, I think, usually of ignorance on the part of parents in regard to the dietetic requirements of young children. Merei, in his treatise on the Disorders of Infantile Development (London, 1850), says that in Manchester, where his observations were made, one child in every five in comfortable circumstances presented rachitic symptoms. In the United States rachitis is rare in well-to-do families, and when it does occur, it can usually, as we shall see hereafter, be traced to dietetic errors.

DIAGNOSIS.—In preparing statistics relating to rachitis it is obviously important that the diagnosis of mild and incipient cases should be clear and unmistakable. What symptoms and anatomical characters indicate rickets? The fact that an infant has reached the ninth month without a tooth, is regarded by Sir William Jenner as a reliable sign of rachitis. In order to determine to what extent dentition is retarded by rickets, and to what extent retarded dentition may be considered a sign of that disease, Dr. H. R. Purdy, Physician to the Outdoor Department of Bellevue Hospital, has made the following observations:—

TABLE I.—*Showing at what age 200 infants showing no signs of rachitis cut the first tooth. Cases consecutive.*

3	cut	first	tooth	at	2	months.	28	cut	first	tooth	at	8 months.
14	"	"	"	"	3	"	20	"	"	"	"	9 "
16	"	"	"	"	4	"	14	"	"	"	"	10 "
20	"	"	"	"	5	"	15	"	"	"	"	11 "
24	"	"	"	"	6	"	8	"	"	"	"	12 "
37	"	"	"	"	7	"	1	"	"	"	"	13 "

Of these infants 132 were wet-nursed; 68 bottle-fed.

TABLE II.—*Showing at what age 43 infants exhibiting one or more rachitic symptoms cut the first tooth. Cases consecutive.*

2	cut	first	tooth	at	4	months.	7	cut	first	tooth	at	11 months.
2	"	"	"	"	5	"	5	"	"	"	"	12 "
3	"	"	"	"	6	"	6	"	"	"	"	13 "
2	"	"	"	"	7	"	3	"	"	"	"	14 "
5	"	"	"	"	8	"	1	"	"	"	"	16 "
6	"	"	"	"	9	"	1	"	"	"	"	18 "

TABLE III.—*Thirty infants without teeth and with pronounced rachitic symptoms. In all these cases the rachitic rosary, enlarged subcutaneous veins, profuse perspirations, abnormal distention, and enlarged joints, were present. Bottle-fed, 21; wet-nursed, 9.*

6	aged	7	months.	1	aged	10	months.	2	aged	13	months.
10	"	8	"	4	"	11	"	2	"	14	"
1	"	9	"	3	"	12	"	1	"	15	"

It is evident from these interesting statistics that dentition delayed until the ninth or even the tenth or eleventh month is not a certain sign of rachitis, but slow teething is common in the rachitic, and therefore aids in the diagnosis. It is one of the diagnostic signs.

In order to determine whether rachitis, incipient or of a mild form, be present, all the signs which characterize it should be considered—the fretfulness, free perspirations upon the head, neck, face, and chest, the tenderness of surface, anæmia, and general deterioration of health, delayed dentition, swelling of the joints, craniotabes, bending of the long bones, rachitic rosary, misshapen head, prominent frontal and parietal

bosses, deformity of the thorax, with depression of the ribs and projecting or misshapen sternum, prominent abdomen, and Harrison's groove distinctly marked. All these signs and symptoms must be considered before making a diagnosis in incipient or mild rachitis. In order to determine the diagnostic value of enlargement of the costo-chondral articulations, "the rachitic rosary," I have examined these joints in three of the New York institutions in children supposed to be healthy or suffering from other ailments than rachitis. In many young children believed to be healthy, these joints are not appreciable on palpation. In others a slight prominence can be felt in one or more joints. In order that the beading of these articulations be sufficient to indicate rachitis, it should, I think, be plainly detected by the fingers in most of these joints. Less than this I should not regard as sufficient evidence of rickets.

AGE.—In a large majority of cases rachitis manifests itself before the age of three years, and if it be first diagnosticated at a later date, it will usually be found on inquiry that its symptoms have had an earlier commencement. Glisson, Portal, and Tripier say that they have seen it commence in children who were well on towards puberty, and Sir William Jenner says that he has seen children of seven or eight years who were only beginning to suffer from rachitis. The following are the aggregate statistics of Bruennische, Von Rittershain, and Ritsche, relating to the age at which rickets occurs:—

	No. of Cases.
During the first half year,	99
" " second half of first year,	259
" " second year,	342
" " third year,	134
" " fourth year,	31
" " fifth year,	17
Between the fifth and ninth years,	21
Aggregate,	903

TREATMENT OF RACHITIS.—*Hygienic Treatment.*—The frequency of rachitis, especially in the cities, and the fact that inheritance is one of its recognized causes, and that manifestations of it appear early in life, render it very important that the parents during the procreative period should be, as far as possible, in a state of perfect health. The most common and potent cause of rachitis occurring after birth is some error in diet, or a disordered state of the digestive apparatus which usually results from improper feeding.

As a preventive of rachitis the infant should if possible be wet-nursed until the age of twelve months. If this be impossible on account of ill health of the mother and consequent deficiency or poor quality of her breast-milk, and the parents be unable to provide a competent wet-nurse, food artificially prepared must of course be employed. During the age in which rachitis usually occurs, cow's milk, properly prepared, should after the weaning be used as a substitute for human milk. Cow's milk contains five times as much casein as woman's milk, and is slightly acid, whereas the latter is alkaline. Nevertheless, if properly prepared, cow's milk is the most convenient and best substitute for woman's milk. In the country, cow's milk obtained fresh, and with

proper attention to cleanliness in its manipulation, may not require sterilization by heat. But that received and used in the city, exposed more or less to an atmosphere containing numerous microbes, it is well to sterilize by subjecting it to a heat of from 165° to 167° F., for a period not exceeding twenty minutes. For infants with feeble digestion it may be well also to peptonize the milk by the use of peptogenic powder, in the manner well known to the profession. A properly prepared farinaceous substance mixed with the milk has not only nutritive properties, but by mechanically separating the particles of casein tends to prevent the formation of curds in the stomach. But as young infants digest starch with difficulty, a flour should be chosen, such as barley or oatmeal, in which the starch is to a great extent converted into dextrin, or better into grape sugar. The conversion into dextrin and into grape-sugar may be effected by the action of the diastase of malt. I am in the habit of employing barley flour subjected to the heat of boiling water seven days, and adding about ten drops of diastase to the gruel of one feeding. The gruel thus prepared, and mixed with sterilized or peptonized milk, is a suitable food for rachitic infants. The theory of Cheadle and others that the most common dietetic error which produces rachitis is a deficiency of fat, and that those rachitic patients do best who are allowed an increase of fat as well as of the proteids in their food, is sufficiently established to influence treatment. The upper half or third of the milk obtained from the bottle or can, is preferable to the lower portion, inasmuch as it contains more cream.

Meat soups, properly prepared according to the age, are useful additions to the diet. I have elsewhere stated that, in one of the institutions of New York, rachitis from being common was made to disappear almost entirely by allowing a more generous diet, a part of which was the daily use, but in moderate quantity, of beef tea. I have employed with apparent good results beef tea prepared as follows: Add half a pound of beef finely hashed to one pint of cold water, and add ten drops of dilute muriatic acid. Allow it to stand cold for half an hour, with frequent stirring; then place it upon the table in a pail or large pan of boiling water, so as to heat it without coagulating the albumin. In an hour it is ready for use. The beef should be carefully selected, so that it does not contain the germs of the tape-worm. The peptonized beef of the shops is also a useful preparation. After the first year, the proportion of farinaceous food, employed with milk, a soft-boiled egg, and light meat-teas, may be gradually increased. In and after the second year, also, easily digested vegetables, well cooked, the juice of the orange, and succulent fruits such as the baked apple, or raw apple scraped and carefully separated from skin and seeds, may be allowed in moderation.

In an address delivered at the meeting of the Section of Diseases of Children of the British Medical Association, August, 1888, Dr. W. B. Cheadle said: "The diet of a rickety child should be carefully examined to ascertain if it contain a due proportion of fat, proteids, and salt. It will be found that it is or has been defective, and it should be at once placed at the correct standard, so that the animal fat equals one-fourth of the total solids, the proteid one-third, the carbohydrates a little over one-third, and the salts about one-tenth. For a little infant these

should be diluted to about the percentage which obtains in human milk. It is not enough to supply fat alone, if proteid and salts are likewise deficient."

The room occupied by the patient should be at about 70° F., of uniform warmth, and not exposed to draughts of air. The garments worn should usually be of woollen, thin and light in the summer, heavier and warm in the winter. Sponging and bathing with water at a temperature of 80° for young children, and from 70° to 75° for older children, the process occupying only a few minutes, and with precautions to avoid taking cold, are useful means of invigorating the system. A child with rachitis should be often in the open air when the weather permits, with precautions always to prevent chilling of the extremities.

Medicinal Treatment.—Medicines which aid the digestion and assimilation of properly selected foods, are sometimes useful. Irritability of the stomach, imperfectly digested stools, flatulence, colicky pains, etc., indicate faulty digestion, which may be improved by pepsin given with each feeding. Tonic remedies designed to improve the appetite and digestion, of a kind suitable for the age and condition of the patient, are often useful. In anæmia one of the readily assimilated preparations of iron should be given. The complications which are so common require special treatment. The laryngismus stridulus, eclampsia, and tetany should be promptly treated.

The bronchial catarrh to which rachitic infants are liable may be best treated by remedies like the following:—

℞ Ammon. chloridi, ... ʒ i.
Syr. tolutan., ... f ʒ ij.
M. Dose, 15 drops every hour or two hours to an infant of from six to ten months.

℞ Ammon. chloridi, } āā ʒ ss.
Ferri et ammon. citratis, }
Syrupi, ... f ʒ i.
Aquæ, ... f ʒ iij.
M. Give one teaspoonful from every two to every four hours to a child of one year.

Some of the rachitic cases, with protracted bronchial catarrh, especially those who also exhibit scrofula, may be most relieved by the syrup of the iodide of iron and cod-liver oil administered three times daily, with the inhalation of moist air containing the turpentine vapor.

In the protracted intestinal catarrh of rachitic infants, I have observed the best results, as far as medicine is concerned, from the following prescription:—

Subnitrate of bismuth, ... ʒ lj. to iij.
Essence of pepsin (Fairchild's), ... ʒ i.
Distilled water, ... f ʒ iij.
Shake the bottle; give from half a teaspoonful to one teaspoonful, according to the age, every two hours.

But a remedy is needed which will act promptly in the cure of rachitis, so as to prevent the evil consequences which its continuance is sure to produce. It is the opinion of many of the best clinical observers, who have had ample experience, that this has been discovered in the daily use of minute doses of phosphorus.

Wegner fed young and growing animals (rabbits and fowls), for months, with small, non-poisonous, and easily assimilated doses of phosphorus, with the result, he believes, of expediting ossification

and producing firmer bone. He says that under the influence of phosphorus the large marrow spaces diminish by the formation of true bone to the size of the Haversian canals in normal bone. According to Wegner, the administration for a lengthened period to the older fowls of finely divided, non-poisonous doses of phosphorus, produced, to a considerable extent, the conversion of cancellous into compact bone, having the normal chemical composition. Kassowitz has recently promulgated his views at some length on the pathology and treatment of rachitis. He says[1] that lime salts are not needed, since the ordinary food contains sufficient lime, and that the farinaceous foods should not be restricted. He adds that phosphorus in small doses restricts the formation of vessels in the growing bones of small animals. Hence it is useful as a means of overcoming the hyperæmia. Kassowitz administers about $\frac{1}{133}$ of a grain in a teaspoonful of cod-liver oil, the dose of course varying according to the age of the infant. The distinguished pædiatrist of Vienna, Dr. Widerhofer, says of this remedy that its employment impresses him with the belief that it is not without benefit in the second year of life and upward. He thinks that it may be useful in the hardening of long bones, but he has not been able to obtain good results in craniotabes.[2] Stärker gives an analysis of 23 rachitic cases treated by Professor Thomas, of Freiberg, in his Clinic. He used the following formula: Phosphorus, 1 centigramme (about $\frac{1}{7}$ grain); cod-liver oil, 100 grammes (about 3 fluidounces). A coffee-spoonful, probably about 1 fluidrachm, was administered twice daily, but variations in the dose according to the age are not mentioned in the report, the patients being between the ages of a few months and four years. Improvement occurred in the general condition in 18 cases, in the cranial development in 15 cases, in dentition in 14 cases, in the shapes of the epiphyses in 21 cases, and in locomotion in 17 cases; but strict attention was also bestowed upon the hygiene, and especially upon the diet.

Soltmann says that good results occurred from the use of phosphorus in 70 cases, which he had under observation, and in no instance were unfavorable effects noticed. W. Meyer obtained similar results in 42 cases. He regards phosphorus as a specific for rachitis. When properly given, it always, he says, produces positive results. Peterson has treated 200 cases with phosphorus, and regards it as a specific. Sigel concludes from the observation of forty cases in private practice that constitutional treatment is of the greatest importance, but instead of the administration of iron, lime, etc., phosphorus should be prescribed. Unruh also made many observations in the treatment of rachitic cases by phosphorus in the Dresden Hospital in 1885 and 1886, and considers it more efficacious than other remedies. Toplitz, of Breslau, treated 518 cases with phosphorus combined with cod-liver oil. No ill effects were observed, and in all the cases improvement occurred in the general condition. Of 208 cases of craniotabes, 176 were cured in eight weeks. In 58 cases of laryngismus stridulus the attacks ceased in from eight to fourteen days, after having continued for months under other forms of treatment. Dentition was also promoted.[3] In America,

[1] Wiener med. Wochen., Nov. 28, 1889.
[2] Münch. med. Woch.
[3] Dr. Vineberg, in New York Med. Jour., 1887.

Dr. A. Jacobi, who has had a large clinical experience, also highly recommends phosphorus in the treatment of rachitis. The dose should be small, even minute, not more than from $\frac{1}{200}$ to $\frac{1}{100}$ of a grain according to the age, three times daily. As regards my own observations, I am not able to express a positive opinion as to the value of the phosphorus treatment, for reasons which I think also apply to many of the cases embraced in the favorable statistics of the distinguished observers mentioned above, to wit, the simultaneous use of cod-liver oil, with improvement in the diet and general hygiene.

The following prescriptions may be employed: first, the *oleum phosphoratum*, made according to the following formula: Phosphorus, 1 part; ether, 9 parts; almond oil, 90 parts; one minim contains $\frac{1}{100}$ of a grain of phosphorus. Or, secondly, the following, known as "Thompson's mixture:" ℞ Phosphori, gr. i.; alcoholis, ♏cccl.; spt. menthæ piperit., ♏x.; glycerini, f℥ij. M. Dose, 6 drops increased to 10, three times daily, to a child of from two to four years. Ten minims contain $\frac{1}{182}$ of a grain, and thirteen minims contain $\frac{1}{100}$ of a grain. Phosphorus should, I think, be given after the meals, in order to prevent irritation of the stomach.

Dr. H. H. Purdy, physician to the large class of children's diseases in the outdoor department at Bellevue Hospital, has preserved statistics of the treatment of rachitis during a year. The cases which furnish the statistics were about 80, and he gives a *résumé* of the results of treatment as follows:—

Some were given cod-liver oil alone, some cod-liver oil with phosphorus, and others phosphorus alone, and of course all the mothers were given instruction in feeding and hygiene. Those infants that received only phosphorus were the slowest to improve. Indeed, in several cases this method of treatment was abandoned because of the absence of signs of improvement. The group treated with cod-liver oil did the best. In fact, all of the infants that could tolerate the oil derived much benefit from it. The group that were given cod-liver oil with phosphorus did very well, but seemingly no better than those that were given only cod-liver oil. The preparation that seems to be the most beneficial is one that is used at the Church Hospital and Dispensary. It is an emulsion of cod-liver oil made with the yolk of eggs. The formula for the emulsion is

Yolks of eggs,	No. x.
Cod-liver oil,	Oij.
Syrup of wild cherry,	Oi.
Sherry wine,	Oi.

One or more teaspoonfuls should be given three or more times daily. In my opinion the treatment by phosphorus is still tentative, notwithstanding its recommendation by so many distinguished physicians, and the old remedies, cod-liver oil and iron, should not be abandoned, although trial may be made of phosphorus at the same time.

Care should be taken to prevent deformities while the bones are soft and yielding. The patient should not be encouraged to stand or use the limbs until they become firmer. He should lie upon a soft and even mattress. Uniform support of body and limbs is requisite in order to prevent curvature. In craniotabes the pillows should be soft, and care should be taken that the yielding parts of the cranium be not unduly pressed upon. The perspiration may be relieved by sponging

with vinegar and water. The patient may be bathed in water a little cooler than the body, and rock salt may be added to the bath.

The attacks of laryngismus stridulus, eclampsia, and tetany, which so frequently complicate rachitis, should be promptly treated by the remedies which are appropriate when they occur under other circumstances; constipation may be treated by enemata of glycerin and water, if not relieved by change of diet.

The surgical treatment of rachitic deformities is sometimes important, but Professor Ogston, of the University of Aberdeen, and other surgeons who have given special attention to them, say that in young patients these deformities frequently diminish during growth, so as to cause little inconvenience in adult life. The measures employed by surgeons in order to cure or minimize the deformities are fully set forth in surgical treatises.

ABSCESSES AND ULCERS.

BY

HENRY R. WHARTON, M.D.,

DEMONSTRATOR OF SURGERY IN THE UNIVERSITY OF PENNSYLVANIA, SURGEON TO THE PRESBYTERIAN, METHODIST AND CHILDREN'S HOSPITALS, ASSISTANT SURGEON TO THE UNIVERSITY HOSPITAL, ETC.

ABSCESSES.

ACUTE ABSCESS.—The almost invariable presence of certain infectious organisms in acute abscesses, staphylococci or streptococci, has led to the generally accepted opinion that this form of disease is directly dependent upon their presence, although Grawitz and Lemière have shown by carefully conducted experiments that suppuration may be caused by the injection of irritating substances unaccompanied by micrococci or ptomaines. Lemière recognizes the possibility of the formation of pus without the presence of micro-organisms, which form of suppuration he describes as chemical abscess, and differentiates this variety from that due to the presence of microbes. He says that in chemical abscesses, the cause being limited, the effect of pus production is limited to the time taken for the irritant to act, and that even if the chemical action be weak, the irritation may be sufficient to produce a barrier of newly formed cells which will encyst the abscess and prevent its spreading. On the other hand, abscesses due to micro-organisms are progressive, not limited, and the germ, when introduced into a favorable soil, can continue to proliferate and bring to the neighboring parts a new infection. For clinical purposes, I think it wise to regard all acute abscesses as the result of infective organisms.

Treatment of Acute Abscess.—The treatment of an acute abscess consists in making a free incision to evacuate its contents. The only modification in treatment which has been practised in recent years consists in the adoption of measures to make the abscess cavity aseptic, and in the use of such dressings as may maintain it in this condition. Before opening an acute abscess the skin surrounding it should be gently washed with soap and water, and finally with a 1-2000 bichloride of mercury solution; a free incision should then be made of sufficient extent to expose the cavity of the abscess and to permit the escape of its contents. The cavity should next be irrigated with water which has been boiled and cooled down to the proper temperature, or with a warm 1-2000 bichloride or 1-60 carbolic solution. When the cavity of the abscess has been thoroughly irrigated, and there is no further escape of pus with the injected solution, if not extensive or very deep, drainage will

not be necessary; if, however, the cavity is large and deep, a perforated rubber drainage tube should be passed to its lowest part, and should be made to project at the most dependent point of the abscess, being secured by a safety-pin passed through its extremity on a level with the skin. In large or irregularly-shaped abscesses a number of tubes may be introduced in the same way, and their extremities may be brought out at different points. Glass drainage-tubes may also be employed, or a few strips of iodoform or bichloride gauze may be passed to the bottom of the abscess cavity, and brought out at the most dependent portion of the incision and used in the place of tubes. The line of incision is next covered by a strip of protective which has been sterilized by dipping it in a 1-2000 bichloride solution, and over this is laid a large pad composed of a number of layers of bichloride, iodoform, or sterilized gauze, and the dressing is completed by the application of a number of layers of bichloride or sterilized cotton, the whole being held in position by a roller bandage or by adhesive straps. If the dressings become soaked with the discharges from the abscess cavity, they should be renewed at the end of twenty-four hours; if, however, the discharge is not copious, the dressings need not be changed for two or three days, when the drainage tubes or gauze drains may be removed. The subsequent dressing of the abscess consists in the application of a pad of gauze and cotton, applied as before described. After opening an acute abscess, it is often found useful, in order to cleanse the cavity thoroughly, to employ an injection of peroxide of hydrogen, and to continue the injection until the effervescence in the escaping discharges ceases, when the cavity should be irrigated with the antiseptic solution as already described.

It has also been recommended in the treatment of acute abscesses that the incision should be made so free as to thoroughly expose the cavity, and that the inner surface should be gently rubbed with a pledget of gauze held with forceps, so as to remove the lining membrane as far as possible, when the ordinary warm antiseptic irrigation and the dressings already mentioned may be employed. The only objection to this method is the free hemorrhage which the destruction of the walls of the abscess entails. If the cavity becomes filled with blood, a strip of protective should be placed over the incision, and a moist gauze dressing, covered by a layer of mackintosh and bichloride cotton, should be applied. If the cavity has been rendered thoroughly aseptic, it is possible that organization of the blood-clot may take place, and that cicatrization may result in this manner. The healing of an acute abscess, if the incision has evacuated the contents freely, is usually very prompt under these methods of treatment.

CHRONIC ABSCESS.—Chronic abscesses are generally of tubercular origin, and as long as they remain chronic do not contain cocci; the material with which they are filled, although it resembles pus in appearance, is, by modern pathologists, not considered to be true pus, since it contains very few corpuscles and consists largely of broken-down and liquefied tubercle. This variety of abscess is classed by many writers as the caseous abscess. True chronic abscesses are occasionally seen in which the collection of purulent matter is surrounded by a dense capsule.

Treatment of Chronic Abscess.—Aspiration.—In dealing with large cold abscesses connected with disease of bone, it is often found satisfactory to employ aspiration, as by this means the contents may be removed, the vitality of the skin surrounding the collection be preserved, and the shock which accompanies the use of an anæsthetic, or the method by free incision, be avoided. As the procedure is one practically unaccompanied by pain, anæsthesia is not required, and the aspiration may be repeated as often as the fluid re-accumulates. The skin surrounding the point at which the aspirating trocar and canula are to be introduced should be washed with soap and water, and with a 1-2000 bichloride of mercury solution, the instruments being placed for a short time before being used in a 1-30 carbolic solution, or in boiling water. If the contents of the abscess have been evacuated by means of suction, the canula should be removed and the small puncture closed with a little sterilized cotton fastened to the skin with a scab of iodoform collodion.

Incision.—Chronic abscesses may also be treated by free incision, and when this procedure is employed it is most important that every precaution should be taken to render the skin surrounding the abscess cavity aseptic, and after the discharge has escaped the parts should be kept aseptic by the application of suitable dressings. The skin around the abscess having been thoroughly washed with soap and water and a 1-2000 bichloride solution, a free incision is made over the most dependent portion, and gradually deepened until the cavity of the abscess is freely exposed. The contents should then be washed out by irrigating the cavity with a 1-2000 warm bichloride or a 1-60 carbolic solution, or, before the use of these solutions, the cavity may be irrigated with peroxide of hydrogen, and the irrigation with carbolic or bichloride solution may subsequently follow. After all discharge has been thoroughly washed out, one or more sterilized rubber drainage-tubes may be introduced and brought out at different points of the line of incision, being secured by means of safety-pins, or a few strips of iodoform gauze may be introduced to secure drainage in place of the rubber tubes. A piece of protective which has been sterilized by dipping in a 1-2000 bichloride solution should next be placed over the wound, and a large bichloride or iodoform gauze dressing, consisting of a number of layers, with several layers of bichloride cotton, should be placed over this, the whole being retained by a gauze bandage. If the dressings become soaked with discharge from the abscess cavity within a few hours, they should be removed and fresh dressings applied in the same manner; if the flow is not excessive, the dressings need not be disturbed for several days, and, when they are removed, if the discharge is slight and the cavity of the abscess seems to be aseptic, the drainage tubes may be withdrawn, an antiseptic dressing being again applied.

Free Incision, with Curetting of the Walls of the Abscess-Cavity.—Another method of treating chronic abscess consists, after having rendered the skin covering the abscess perfectly aseptic, in making a free incision in the usual way and allowing the contents to escape, then irrigating the cavity to remove any discharge, and finally curetting its walls thoroughly and again irrigating it with a 1-2000 bichloride solution, or with warm water which has been sterilized by boiling. As this curetting is apt to be followed by quite free hemor-

rhage, it is well after irrigation to pack the cavity firmly with strips of iodoform gauze, then applying a large gauze dressing with layers of bichloride cotton in the ordinary manner. As soon as the dressings have become soiled with discharge they are removed, and the gauze packing is also removed if it has become loose; but it will often be found that this will remain in place for a number of days, and if the wound is aseptic it need not be withdrawn until it has become quite detached. When it is finally removed, the cavity should be gently irrigated with a bichloride solution, or with warm sterilized water, and should be again gently packed with strips of iodoform gauze and the external dressing applied as before. By this method of treatment the cavity of the abscess fills up with granulations.

Injection of Iodoform and Glycerin.—Another plan consists, after first sterilizing the skin covering the abscess, in passing a narrow-bladed bistoury through the tissues until its point enters the cavity; before the knife is removed a grooved director is introduced along its blade as a guide, the knife is then withdrawn, and the contents are allowed to escape along the groove of the director, their evacuation being facilitated by gentle pressure from the outside. When the cavity is empty, it is washed out with a warm 1-2000 bichloride, or a 1-60 carbolic solution, introduced through a syringe the nozzle of which enters the small puncture in the skin. This fluid is allowed to escape by again passing the grooved director into the small puncture, and the cavity is then filled up with an iodoform and glycerin emulsion, 1-10, introduced by means of the syringe. The surface of the skin should next be thoroughly irrigated, and a small compress of iodoform gauze placed over the puncture, and held in position by a pad of bichloride gauze and cotton, with a bandage, or adhesive straps. Another method of using the iodoform emulsion consists in making a free incision into the abscess, irrigating its cavity with warm bichloride or carbolic solution, and then filling it with iodoform emulsion and bringing the edges of the incision together with sutures, applying a full antiseptic dressing. In many cases of chronic abscess, the removal of the contents is only one step toward securing healing; in cases arising from diseased bone, if it be possible to remove the bone this should be done, even if very free and extensive incisions are required for the purpose. Antiseptic irrigation should then be practised, and free drainage should be secured by the introduction of drainage-tubes passed to the deepest portions of the cavity, which is packed with iodoform gauze, a large gauze dressing being applied externally, and renewed as often as it becomes soiled.

ULCERS.

The treatment of ulcers differs little from that generally practised before the introduction of the antiseptic and aseptic methods of wound treatment, the same procedures as regards rest, mechanical support, and the use of constitutional remedies being employed, and the changes concerning only the treatment of the ulcerated surface itself.

HEALTHY ULCER.—This variety of ulcer has a tendency to rapid healing if the part upon which it is situated be kept at rest, and the

granulating surface be covered to protect it from injury and from the accumulation of foreign matters, although, even when the latter conditions are not present, we often see very rapid cicatrization, such as that which takes place under a scab made up of the dried discharge from the granulations and foreign matters brought into contact with them. This method of healing is taken advantage of sometimes in small ulcers, where an aseptic scab is formed by dusting the surface with powdered iodoform or aristol. It is, however, a matter of common experience that even healthy ulcers heal more promptly if kept perfectly clean and free from irritation.

Treatment of Healthy Ulcers.—The skin surrounding the ulcer should be washed with soap and water, and shaved if hairs be present, the surface of the ulcer being then irrigated with a solution of boric acid, or with boiled water, and being covered with strips of protective which have been sterilized by dipping them in a 1-2000 bichloride solution, and then washed in one of boric acid. These strips should be large enough to cover the ulcer and extend a very short distance beyond its edges. Over them should be placed a pad of bichloride, iodoform, or sterilized gauze, consisting of at least a dozen layers, and large enough to extend in all directions a few inches beyond the edges of the ulcer; over this, again, is placed a layer of sterilized or bichloride cotton, a little larger than the gauze pad, and the dressing is held in position by the turns of a roller bandage, or by strips of adhesive or rubber plaster. This dressing need not be changed for some days, unless it becomes soiled, and in re-dressing the ulcer the same method should be adopted. The protective prevents the adhesion of the gauze to the granulations, and being applied in strips slightly overlapping each other, allows the discharge to find its way out and to be disseminated through the gauze. If for any reason another form of dressing is desired, good results may be obtained by use of an ointment consisting of carbolic acid ♏ xvi., boric acid ʒ ij., vaseline ʒ i. This is spread upon a piece of lint, which should be fenestrated, and a little larger than the ulcer, and which, after the part has been cleansed and irrigated is gently laid over the granulating surface and covered with gauze, cotton, and bandages in the way already described. At the end of three or four days the dressing should be removed, and a new dressing applied in the same manner. If the granulations become exuberant, they should be touched with the solid stick of nitrate of silver.

INFLAMED OR PHLEGMONOUS ULCER.—This condition may develop in a healthy ulcer either from accidental irritation, or from a change in the constitutional state of the patient. In this variety of ulcer the granulations at first become intensely red, and then dusky or gray, while a thin sanious discharge escapes from the surface; the surrounding skin and cellular tissue become involved in phlegmonous inflammation, which gives the part a dusky red and glazed appearance.

Treatment.—In the treatment of this form of ulcer it is important to put the part at absolute rest, and if possible to elevate it; if the ulcer be situated upon one of the extremities, so that it is possible to employ continuous irrigation, this will be found to be very efficient. The part containing the ulcer should be placed upon a rubber sheet so arranged as to carry off the water, and a piece of gauze composed of a

number of layers and moistened in a weak carbolic solution, 1-80, or in boric-acid solution, should be laid over the ulcer and the inflamed surrounding tissues. Continuous irrigation is then practised by suspending over the part an irrigating bottle or can, filled with warm or tepid carbolic or boric acid solution, a small stream of the fluid being allowed to run continually over the gauze which covers the inflamed area. The constitutional condition of the patient should also receive attention, and the use of saline laxatives and of the tincture of chloride of iron is often followed by the best results. Usually after the use of irrigation for a short time, twenty-four or forty-eight hours, it will be found that the inflammation of the surrounding tissues has subsided, and that the ulcer presents a healthy appearance, when the irrigation may be dispensed with and the ulcer dressed as a healthy ulcer in the way already described. If for any reason the treatment by irrigation is not feasible, a very satisfactory method consists in putting the inflamed part at rest and covering it with a piece of lint spread with an ointment of ichthyol and lanolin, one part of the former to four parts of the latter. The dressing is completed with a layer of cotton and a bandage. Under this treatment, combined with the use of constitutional remedies, the inflamed and unhealthy appearance of the ulcer and surrounding tissues rapidly disappears.

SLOUGHING OR PHAGEDÆNIC ULCER.—This form of ulcer is found in cachectic or ill-nourished individuals, and in addition to local treatment, the constitutional condition of the patient demands prompt attention.

Treatment.—The surface of the ulcer should first be cleared from sloughs by a stream of warm carbolized water, or the sloughs may be removed by forceps and scissors. The surface should next be washed or sprayed with peroxide of hydrogen, 15-volume solution, and a wet dressing consisting of a number of layers of lint or gauze moistened in a 1-60 carbolic solution should be placed over the ulcer and covered with waxed paper or rubber tissue. This dressing should be changed at the end of twelve hours, the ulcer being irrigated with peroxide of hydrogen, and then with a 1-60 carbolic solution, and the wet dressing should be continued until the sloughs have separated. If, however, the sloughing process continues and tends to assume a phagedænic form, the surface of the ulcer should be thoroughly dried with absorbent cotton and touched with nitric acid applied by means of a swab, and after this, to arrest the further action of the acid, should be irrigated with lime-water. Powdered iodoform, or acetanilide, should then be dusted over the ulcer, this being covered by a pad of moist gauze. The cauterization often arrests the phagedænic action, and when the sloughs separate, a healthy granulating surface is left. The *constitutional treatment* of a patient suffering with this variety of ulcer is also a matter of the first importance. He should be given stimulants, iron, and opium, the latter remedy, in doses of from one to three grains in twenty-four hours, seeming to exert a beneficial influence in many forms of gangrenous disease, as pointed out by Mr. Pollock.

ŒDEMATOUS ULCER.—This variety of ulcer, which presents large, pale, flabby granulations, is often seen in cases in which wet dressings

or poultices have been continued for a long time, and is apt to occur in patients whose general health is defective.

Treatment.—In this form of ulcer the application of a 20-grain solution of nitrate of silver, or of a 20-grain solution of carbolate of zinc, is often followed by a change in the character of the granulations. If, however, these project much above the surface of the ulcer, they should be freely touched with the solid stick of nitrate of silver, and after this boric-acid ointment may be applied on lint, with a compress of cotton and the support of a bandage. At the same time tonic remedies should be administered to correct the anæmic condition of the patient which often coexists. As soon as the granulations assume a healthy appearance, the treatment should be that of a healthy ulcer.

IRRITABLE ULCER.—This form of ulcer differs from the healthy ulcer in the fact that the granulations covering its surface are smaller and redder than those seen in the latter, while at the same time the ulcer is the seat of intense burning pain.

Treatment.—The treatment consists in touching the surface of the ulcer with a 5 or 10 grain solution of nitrate of silver, dusting it with iodoform or aristol, and applying over the granulations a piece of lint spread with boric-acid ointment, a pad of sterilized cotton, and a bandage. As a depressed condition of health is often associated with this form of ulcer, tonics should be employed in connection with the local treatment.

Fig. 1593.

Warty ulcer of leg.

VARICOSE ULCER.—The *treatment* of ulcers dependent upon or coexisting with a varicose condition of the veins, consists in the application of a stimulating solution of nitrate of silver, 5 or 10 grains to the fluidounce, with a dressing of boric-acid ointment and a pad of gauze or cotton. This dressing should be combined with support of the venous circulation of the part, which is accomplished by the use of a firmly applied muslin or elastic bandage.

WARTY ULCER OF CICATRICES.—This is a very persistent form of ulcer, which is sometimes known as the warty ulcer of Marjolin, and which occurs in wounds which have only partly cicatrized, or which have broken down again after cicatrization. Some of the ulcers are non-malignant, being

of a fibro-cellular character, while others show by their structure that they are true epitheliomata. They are often associated with a carious condition of the bone in their immediate vicinity. I have seen a number of cases which occurred in partially cicatrized gunshot wounds, often of many years' standing, and in one case at least twenty years had elapsed before the patient came under my observation. The ulcer is usually covered by granulations having a papillary appearance, like condylomata, which often protrude above the surface of the surrounding tissues. A typical case of warty ulcer, resulting from a gunshot wound received in the late war, is shown in Fig. 1593. This form of ulcer may cause little discomfort for a long time, but it gradually increases in size, the granulations becoming more exuberant and the patient ultimately experiencing intense pain at the seat of disease. The discharge from the ulcer is sometimes profuse and very offensive.

Treatment.—The treatment of this form of ulcer consists in free excision of the diseased structure, if this can be accomplished, with the removal of any carious bone that is associated with it; but in many cases, when situated upon the limbs, it is necessary to resort to amputation in order to completely remove the disease. There seems to be little tendency to recurrence if the morbid structures are freely removed by excision or amputation. I have in mind one patient, whose limb was amputated for this variety of ulcer, following an old gunshot wound, who ten years after the amputation of the limb had no evidence of any return of the disease.

INDOLENT OR CALLOUS ULCERS.—These ulcers are generally situated upon the lower part of the leg, and are apt to affect persons who have passed the middle period of life. The surface of the ulcer is concave, and its edges are raised and indurated, the granulations being of a dull red color and covered by small grayish sloughs, while the secretion from them is thin and offensive.

Treatment.—If it is possible, the patient should be confined to bed, as repair is much more rapid when the part upon which the ulcer is situated is at absolute rest; but as this form of ulcer is generally met with in persons of the laboring class, the patients have to go about attending to their ordinary vocations, and under these conditions, though the time of healing is longer, the final result is no less satisfactory.

The skin surrounding the ulcer should be washed with soap and water, and hairs, if present, should be removed by shaving. The surface of the ulcer should next be irrigated or sprayed with peroxide of hydrogen, and, when effervescence has ceased, with a 1-2000 bichloride solution. A pad composed of several layers of lint wet in 1-60 carbolic-acid lotion should next be laid over the surface and covered by a sheet of rubber tissue, and over this should be placed a pad of absorbent cotton and the turns of a roller bandage. This dressing should be changed every day for two or three days, and the surface of the ulcer on each occasion should be sprayed with the peroxide of hydrogen and irrigated with the 1-2000 bichloride solution. At the end of this time it will usually be found that the edges of the ulcer are much less indurated, and that the granulations present a much more healthy appearance. The dressing now employed should consist in strips of protective, which have been dipped in a 1-2000 bichloride solution, slightly

overlapping each other, until the whole surface of the ulcer is covered. Over these strips is placed a pad of bichloride gauze, consisting of ten or twelve layers, large enough to extend beyond the edges of the ulcer in all directions, and freshly wrung out of a 1-2000 bichloride solution, while over this pad is placed another of bichloride cotton. The dressing is then held firmly in place by a bandage applied (in case of ulcer of the leg) from the toes to the knee. The bandage should be applied firmly, either as a spiral reversed bandage, or as a spica bandage of the leg, the latter retaining its place better than the former if the patient is compelled to walk about during the course of treatment. This dressing should be renewed every second or third day until the surface of the ulcer presents a healthy granulating surface and the discharge has no odor. After this time the use of bichloride irrigation may be omitted, and the ulcer may then be dressed as a simple or healthy ulcer. If there is a tendency for small sloughs to adhere to the surface, which are not removed by the action of the peroxide of hydrogen, the use of an acidulated solution of pepsin (pepsin 3 grains, hydrochloric acid 2 minims, water a fluidounce) will often liquefy them and cause their rapid removal. It is important that this solution should be in contact with the ulcer for some time, to accomplish the desired result. In some indolent ulcers, where the ulcerated surface is very extensive, even after the condition of the surrounding parts has been improved by the treatment above mentioned, it is impossible to obtain cicatrization, and in such cases some of the various methods of skin-grafting or skin-implantation may be employed with advantage; in other cases, where the extent of the ulcer is so great that repair cannot be expected under any form of conservative treatment, amputation of the affected part may be required.

Skin-Grafting in Ulcers.—In the case of large ulcers such as occur after burns or scalds where there has been extensive destruction of the skin, we may have a broad surface covered by healthy granulations, and in such cases skin-grafting may be employed with advantage. The skin-grafts may be taken from the thigh or arm of the patient, or from recently amputated limbs; the skins of frogs and birds, and the hairless skin of young animals, have also been employed. The surface of the ulcer should be irrigated with a warm solution of boric acid, or with a warm normal salt solution, 0.7 per cent., and the grafts, taken from a portion of skin which has been sterilized by washing with soap and water and then with bichloride solution, are placed upon the granulating surface at a number of points, and are applied in lines transversely across the surface of the ulcer, so that a number may be covered by one strip of protective. Over each line of grafts a strip of protective, which has been sterilized and then dipped in boric acid or normal salt solution, is next laid, and a strip of isinglass plaster is fastened to the sound skin at one edge of the ulcer and is carried directly over the protective and fastened to the skin on the opposite side. This serves to keep the protective in place, and to press the grafts firmly upon the granulating surface. A number of these strips of protective and isinglass plaster are applied, until all the lines of grafts have been covered in. A pad composed of a number of layers of borated or sterilized gauze, and a few layers of borated or sterilized cotton, are

next placed over the whole surface of the ulcer, and the dressings are held in place by a firmly applied bandage. This dressing is not disturbed for a week, and when it is removed the grafts are generally found fully vitalized. The surface of the ulcer is then irrigated with a warm boric or saline solution, and pieces of protective are re-applied over the grafts with layers of gauze and cotton as before. This second dressing is not disturbed for three or four days, by which time the grafts are so firmly attached that the dressing thenceforth differs in nowise from that of a simple or healthy ulcer.

Thiersch's Method of Skin-Grafting.—To secure a favorable result by this method of skin-grafting, the surface of the ulcer, if it presents an unhealthy appearance, should be freshened with a curette, and then should be irrigated with normal salt solution, hemorrhage being controlled while the grafts are preparing by a compress wrung out of warm salt solution and applied directly to the part. The skin from which the grafts are to be taken should be thoroughly washed with soap and water, and then scrubbed with a solution of corrosive sublimate. The most convenient situation from which to obtain them is the arm or thigh. Long strips of skin are cut with a sharp razor, as wide as the part will allow; the subcutaneous fat should not be included, but the whole thickness of the true skin is necessary. Strip after strip, obtained in this way, is placed upon the raw surface and pressed firmly in position until the whole is covered. Narrow strips of protective, laid as a lattice-work over the grafts, should next be applied, and over these a compress wet with the salt solution, several layers of sterilized cotton, and a bandage. The external dressing, consisting of the cotton and compress, should be renewed after several days, but the protective need not be removed until the expiration of five or six days, when the grafts will usually be found to have formed adhesions. After their vitality is assured, the dressing of the ulcer should be simply a protective one.

Transplantation of Large Skin-Flaps.—Krause recommends, in the grafting of ulcers, the transplantation of one or more large skin-flaps. The surface to which the flap is to be transplanted should be excised or thoroughly curetted, and the edges, if unhealthy in appearance, should also be removed. The wound is irrigated with normal salt solution, and the hemorrhage is controlled by the application of a compress of sterilized gauze, no ligatures being used. The skin to be transplanted must be disinfected by washing it with soap and water, removing any hairs which are present by means of a razor, and should be thoroughly scrubbed with ether. The flap is then dissected up, and is made as thin as possible, not including the fat, but simply the entire epidermis and cutis. It should be cut a little larger than the surface which it is to cover, if only one flap is used. The flap or flaps are next pressed firmly upon the raw surface, the blood acting as the best adhesive medium. When the entire surface of the ulcer is covered in an exact manner, the flaps are held in position with a five-per-cent. iodoform gauze pad, and over this is placed a large antiseptic dressing. The first dressing is removed in from four to five days, and if any blebs have formed between the cutis and epidermis, they should be opened. A similar dressing is again applied, and allowed to remain for a few days longer. It is often a matter of several weeks before the healing of the ulcer is accomplished under this method of treatment.

TUBERCULAR ULCER.—This form of ulcer results from a tubercular abscess of the cutaneous or subcutaneous tissues and lymphatic glands, and usually occurs in early life. A tubercular ulcer presents very characteristic symptoms, its edges being undermined and presenting a dull-purple, congested appearance, while its granulations are dark-colored and flabby, and the discharge usually thin.

Treatment.—The undermined edges of the ulcer should be trimmed away with scissors or knife, and the granulating surface should be thoroughly curetted. If the ulcer has originated in lymphatic glands which have broken down, the gland-tissue and the sheaths of the glands should be removed. It should then be irrigated with a 1-2000 bichloride solution, and the freshened surface should be well dusted with powdered iodoform, or should be covered with strips of gauze soaked in iodoform emulsion and glycerin (1-10), this in turn being covered with a pad of iodoform gauze and a few layers of bichloride cotton. Under this dressing, which should be renewed every two or three days, healing will often occur very rapidly. In addition to the local treatment, the patient should be given iodide of iron and cod-liver oil, and a nutritious diet; stimulants also are indicated in many cases.

SYPHILITIC ULCERS.—Two forms of syphilitic ulcer are seen among the later manifestations of constitutional syphilis; the ulcer resulting from a broken-down gumma, and the serpiginous syphilitic ulcer; the latter is often preceded by the development of nodules in the skin.

The *ulcer resulting from a broken-down gumma* may have clearly cut edges, or these may be undermined, if the destruction of the subcutaneous tissue has been greater than that of the skin. The surface of the ulcer is usually covered by grayish sloughs.

Treatment.—The ulcer should be thoroughly irrigated or sprayed with peroxide of hydrogen and washed with a 1-2000 bichloride solution, to cleanse it and remove as far as possible the sloughs. It should then be dusted with powdered iodoform or aristol, or the iodoform may be applied in the form of an ointment in the strength of 15–30 grains to the ounce of vaseline. The dressing should be completed by the application of a pad of iodoform gauze and a few layers of cotton. In this form of ulcer there is little chance of healing unless active constitutional treatment is instituted at the same time. The patient should be given iodide of potassium in full doses, and in many cases this drug is well combined with the biniodide or bichloride of mercury, while sometimes, in addition to the above remedies, the use of iron and cod-liver oil is followed by the best results. The repair of syphilitic ulcers is usually very rapid under the use of these local and constitutional remedies.

The *serpiginous syphilitic ulcer* is usually preceded by the development of nodules or tubercules in the skin, which are similar in their structure to the larger gummata. The tubercules break down, leaving ulcers which become serpiginous and may involve a considerable amount of tissue.

Treatment of Serpiginous Ulcers.—The surface of the ulcer should be sprayed with peroxide of hydrogen to cleanse its surface, and the ulcer and swollen tissues surrounding it should be covered by an ointment consisting of

Ung. hydrarg.	ʒ iij.
Acid. salicylic.	gr. xij.
Ung. resinæ	ʒ iv. M.

This ointment should be spread upon soft kid and applied to the ulcer and infiltrated tissues, being renewed every twenty-four hours. Iodoform, in the form of either a powder or an ointment, may also be employed in this form of syphilitic ulcer. As a general rule, cauterization should be avoided in serpiginous ulcers, unless it be found that the ulcer is spreading rapidly, and then it is better to make one thorough cauterization with the acid nitrate of mercury, rather than to employ mild cauterization frequently; an iodoform dressing should be then applied. As a rule, however, the application first mentioned, combined with constitutional treatment, will be found most satisfactory. In this form of ulcer it is often found that small doses of iodide of potassium combined with mercury act better than larger doses, so that I usually employ the following combination:

Potassii iodidi	gr. v.–x.
Hydrarg. biniodidi	gr. $\frac{1}{16}$.
Elix. cinchonæ	f ʒ i. M.

One fluidrachm in water, three times a day, after meals.

A certain amount of scarring is left after the healing of either of these forms of ulcer.

GANGRENE AND GANGRENOUS DISEASES.

BY

E. M. MOORE, M.D.,

EMERITUS PROFESSOR OF SURGERY IN THE UNIVERSITY OF BUFFALO, ETC.

GANGRENE.

THE constitutional disturbance in gangrene is due to the absorption of toxines, which are the result of chemical changes produced by the action of microbes upon the tissues and fluids. When these are absent the dead tissue produces little or no effect upon the blood. It may be separated, or gradually absorbed and discharged through the emunctories, with no perceptible constitutional symptoms. The chemical construction of these toxines or ptomaines has thus far received slight elucidation, but something has been gained, and at this moment the field of inquiry is perhaps the most important in the range of chemical investigation.

The surgeon recognizes the fact that life is often lost when only a small portion of tissue is invaded, and often saved when a whole limb as far as the knee is lost by gangrene. Indeed, it is now well understood that to no single microbe can the putrefactive changes be ascribed. But the greater or less virulence of some well-known forms can be distinctly asserted. Thus we find that the staphylococcus and streptococcus pyogenes are sufficient to produce gangrene, as shown by their exclusive presence in the early stages of furuncle and carbuncle. But the virulence of the toxines resulting from the action of the bacillus of Rosenbach is vastly greater, although the extent of destruction of tissues may be the same in both cases. The ptomaines extruded into the tissues beyond the microbic colonies are capable of absorption.

VARIETIES OF GANGRENE.—The two broad varieties of gangrene, moist and dry, have an important clinical and bacteriological significance. The tissues in the dry variety are not invaded by microbes, and therefore become mummified, producing very slight if any constitutional disturbance; but in the moist form the tissues become the nidus for various microbes, such as those producing pus, as well as the bacillus of putrefaction of Rosenbach. The difference of prognosis in the two varieties has always been recognized by surgeons.

TREATMENT OF GANGRENE.—But little can be added to what is already known. The discovery of the destructive microbes has added

but little to our therapeutics. Observation had anticipated what science has lately taught. The freer use and more careful application of antiseptics in the neighborhood of the living tissue has been somewhat advanced. But the method of employing bromine in hospital gangrene, and nitric acid in facial carbuncle, cannot be improved by any knowledge we now possess of the etiology of these diseases.

AMPUTATION IN GANGRENE.—The rule of waiting for the formation of the red line, which the long and universal experience of surgeons had fully justified until within a few years, has undergone much modification. A better recognition of the pathological conditions present has determined marked exceptions to the former rule. These exceptions will be stated below.

HOSPITAL GANGRENE.—When we regard the peculiar method of invasion by the microbes, it would seem as if the cause of hospital gangrene must be specific. Thus far, however, no special form has been discovered, the bacillus of Rosenbach and the cocci of suppuration being those that are found. Happily the disease is one that will seldom be seen again. The antiseptic mode of treating wounds will bar the development of hospital gangrene. Like scurvy, its horrors will be historical. The antiseptic treatment of this form of gangrene had already been learned, and no improvement in its therapeutics has been added since the discovery of its cause.

SENILE GANGRENE.—The course of this disease is, as has been stated above, usually slow. But it has a tendency to the development of thrombosis, the occurrence of which will suddenly change the whole aspect of the case. The gangrene may have been confined for weeks to the toe, but suddenly it travels in three days up to the knee. This can only be caused by thrombosis, resulting in complete obstruction of an artery. The question of amputation, as regards the proper time of its performance in this special form of gangrene, has always puzzled surgeons. The red line has been waited for, but even when pretty well established the disease will extend beyond it, and thus destroy the hope of relief by amputation. There is difficulty and, perhaps, impossibility of diagnosis as regards the exact point of occlusion in the artery, and the amputation may not be high enough. The operation is in itself a severe one, and the disease occurs in old age. There is to be considered also the depression arising from the disease while waiting for the formation of the line. Even if there be no recurrence of the gangrene, the life may still be lost. In view, however, of the diminished danger of amputation since the use of antiseptic measures, it is often better to perform the operation before the red line forms, especially if the course of the gangrene is more rapid than usual. The loss of a limb is of greater importance in early than in later life. Less risks to save a limb should be taken in the old than in the young. To be assured of getting above the obstruction in this form of gangrene, it will be wise to amputate above rather than below the knee.

Gangrenous Diseases.

Bed-Sores.—But little can be added to what has been said in the article on Gangrene in Vol. I. The habit of rubbing the back, and especially the parts that are excessively pressed on, has become such an established usage in nursing, that the danger of bed sores forming is less than it was formerly. Local applications of acidulated water, to neutralize the alkaline secretions, possess a definite power. The acetate of aluminum is a favorite drug for this purpose, and even after the skin has broken and pus has formed, it is relied upon by Dr. Senn as the safest and most reliable antiseptic in these cases.

Noma.—The cause of this disease is regarded by Lingard as a special bacillus of unusually large proportions, which makes its way through the mucous membranes. This gives opportunity for the entrance of the cocci of suppuration, and also of the saprophytes of putrefaction.

Symmetrical Gangrene.—To what has already been said, I may add that Morven's disease is sometimes a cause of this form of gangrene. Much obscurity still hangs over the etiology of this affection. Morven refers its seat to the spinal cord, but also admits that it may be one of the manifestations of peripheral neuritis. It appears at first on one side, but is apt to become symmetrical, attacking the fingers and toes, producing felons in the first stage and necrosis afterward. The condition is a chronic one.

Diphtheritic Gangrene.—Of this form we may say that the destruction of tissue is not deep. It may be regarded as due simply to the Klebs-Loeffler bacillus. No special treatment other than what is called for in the treatment of diphtheria has thus far been brought out. Perhaps the peroxide of hydrogen has the greatest power in arresting this form of gangrene.

Ergotism.—Of this disease little need be said. Like hospital gangrene and scurvy, it will probably, in future, only be known in history. It has been suggested that a persistent spasm of the arterioles in ergotism is the cause of such a diminished circulation as to produce gangrene.

Embolic Gangrene.—Among the causes of embolism may be the formation of a thrombus from the rupture of the intima of an artery by violence. Thus a rough spot gives an opportunity for the formation of a fibrinous mass that may break away and furnish the plug. Besides careful attention to the maintenance of the temperature of the part affected, and favoring the circulation, as already recommended, little is to be done. The return circulation is often established, but if gangrene of the extremity occur, amputation should be practised, and we should not delay for the formation of the red line. If we can discover pulsation of the main artery in the limb, the amputation should be at the point at which such pulsation is detected.

FURUNCLE.—The bacteriologist finds in the fluid of furuncle the position of the pathogenic cocci. That most usually found is the staphylococcus pyogenes aureus. But all the other varieties of pus-producing cocci may be present. There can be but little doubt that they make their entrance through the sebaceous glands. We have in furuncle the evidence of the power of these microbes to produce gangrene unaided by any of the putrefactive bacteria.

CARBUNCLE.—This disease should no longer be called anthrax, which name should only be used to designate malignant pustule. The two diseases are entirely distinct, as proved by their special microbic origins. Both render the part susceptible to the invasion of saprophytes after their special development. As stated before, two opinions have been held with reference to the cause of carbuncle, one that it is special and unknown, the other that it has the same origin as furuncle, or, in other words, that carbuncle is an aggregation of furuncles. The latter view seems now to be established by conclusive experiments and reliable clinical observations. Modern surgery seeks in the treatment of carbuncle the destruction of the invading microbes as the first indication. It will be seen, however, that as the result of clinical observation alone, most surgeons have for a long while carried out this plan more or less perfectly. The points of suppuration in the hair follicles and their appendages are shown early in carbuncle, and are numerous. Some of these enlarge more rapidly than others, and present a circular opening resembling that of a furuncle. Whether we employ the expectant plan, or make crucial incisions, the destruction of the central portion of the skin is almost certain. If the microbes are destroyed early, the skin may be largely saved. To attain this object, I know of no better treatment than that proposed by a friend, the use of carbolic acid and glycerin, one part to five. Though of poisonous strength, this preparation becomes harmless when properly used, while if less strong it is inefficacious. In employing this remedy a piece of absorbent cotton is saturated with the mixture and then drawn out and twisted. This movement expels most of the fluid and renders the cotton nearly dry. The openings of the carbuncle are enlarged by crucial incisions, each half an inch in length. The cotton rope is then pushed in with a probe and well packed at various points. The inflammation and swelling rapidly subside, and the skin is preserved. The end of the rope being left out of the opening, it is easily removed, and the dressing is renewed each day. Riedel has very recently urged the use of free incisions as the best means of preserving the skin.

ANÆSTHETICS AND ANÆSTHESIA.

BY

ALBERT I. BOUFFLEUR, B.S., M.D.,

PROFESSOR OF PRACTICAL ANATOMY IN THE NORTH-WESTERN UNIVERSITY WOMAN'S MEDICAL SCHOOL; LECTURER ON ANATOMY IN THE RUSH MEDICAL COLLEGE; SURGEON TO COOK COUNTY HOSPITAL, CHICAGO.

THE statement made by Professor Lyman, in the article on Anæsthetics and Anæsthesia in Volume I. of this work, that "it is impossible to employ any anæsthetic agent without in some small degree, at least, approaching the confines of danger," has been supported by the results of experimental research upon animals, and by clinical experience upon man, during the past decade. While the relative safety of the different anæsthetic agents has not been changed, many phenomena have been carefully investigated, conclusions have been harmonized, the value of some danger signals seems to have been conclusively settled, and the treatment of serious conditions has been changed from a mere general routine to a more rational method of practice.

From an historical standpoint, recent evidence shows conclusively that the honor of the first use of the principal anæsthetic substances—ether and chloroform—belongs to two American physicians. The data presented by Dr. L. B. Grandy [1] seem to prove beyond a doubt that to Dr. Crawford W. Long, of Jefferson, Ga., belongs the honor of having first used sulphuric ether for surgical anæsthesia, while a committee of the Chicago Medical Society, after a thorough investigation of the subject, decided, for reasons given in its report,[2] that Dr. Samuel Guthrie, of Sackett's Harbor, N. Y., was the first user of chloroform.

The agreeable odor, concentration, rapidity of action, rarity of bad after-effects, and ease of administration of chloroform are so much in contrast with the usual effects of ether, that practically all experimentation and observation have been conducted with the hope that, with a full knowledge of its effects, means of fortification or restoration would be developed which would enable the surgeon to employ this potent substance with comparative safety. Three of the most important series of experiments have been conducted under the direction of Surgeon Lieutenant-Colonel Lawrie, for the Nizam of Hyderabad, to determine the phenomena and dangers attending the inhalation of chloroform. The conclusions of the two Hyderabad chloroform commissions may be summarized as follows:—

Inhalation of chloroform freely diluted with air causes a gradual fall of blood-pressure—providing the animal is not prevented from breathing.

[1] Virginia Med. Monthly, 1893.
[2] Annual of Universal Medical Sciences, 1892; Hare, Practical Therapeutics.

The absorption of the residual chloroform in the lungs causes the fall to continue after inhalation has been stopped.

Struggling increases inhalation and, therefore, produces more rapid fall, and if associated with gasping may lead to dangerous depression.

Slowing or temporary stoppage of the heart is not dangerous (providing respiration is undisturbed).

The temporary exhaustion of the vagi following stimulation produces danger.

Operations cannot produce syncope.

Chloroform tends to prevent danger of shock.

Chloroform always arrests respiration before the heart's action.

Chloroform, in itself, does not endanger life in cases of fatty heart, but slight exertion may cause death in patients so affected.

Hemorrhage has no effect upon the narcosis.

Ether cannot cause anæsthesia unless air is excluded.[1]

The third series of experiments, made by Drs. Hare and Thornton, confirms in the main the foregoing.[2] These writers hold, however, that depression of the circulation occurs with the inhalation of an excessive dose, which effect is chiefly due to centric vasomotor depression and final depression of the heart muscle. They believe that death practically always results from respiratory failure, provided the heart is healthy.

In discussing the second Hyderabad Commission's report, Alexander Wilson, anæsthetist to the Manchester Royal Infirmary,[3] holds that the respiration indicates the amount of chloroform inhaled, while the pulse indicates the way in which it is being utilized by the circulation—a slow pulse allowing free administration of concentrated chloroform vapor, while with a full-bounding pulse even dilute vapor may be dangerous. He says that the results of the Commission's experiments justify watching the pulse as well as the respiration. Buxton[4] presents the results of his extensive clinical experience with anæsthetics on man —and such must be admitted to be of more practical value than the conclusions formed from experiments upon animals—and believes, as McWilliams seems to have demonstrated,[5] that inhalation of chloroform is attended with cardiac dilatation from the first, and that this is from the direct effect of the substance upon the heart muscle. Unger[6] and others conclude from their investigations that the prolonged inhalation of chloroform produces fatty degeneration of the heart muscle. The extensive cross-circulation experiments of Gaskell and Shore[7] are very ingenious, and, could they be taken without reserve, would indicate direct action of chloroform upon the heart substances. But the opportunities for error, and the highly artificial conditions produced, render the results thus obtained almost useless to the practising physician. Hare and Thornton,[8] in their conclusions, practically admit that both cardiac and respiratory death can take place, but that respiratory failure occurs first where the heart is healthy. If the heart is diseased and the depression of chloroform is added, sudden arrest may occur without any premonitory disturbance of either respiration or pulse.

It is evident that all the phenomena attending the inhalation of chloroform have not been definitely settled, and until the results of ex-

[1] Lancet, 1890; Therapeutic Gazette, 1893; Annual of Universal Med. Sciences, 1891.
[2] Therapeutic Gazette, Oct. 16, 1893. [3] Manchester Medical Chronicle, 1890.
[4] British Medical Journal, 1892. [5] Ibid., 1890. [6] Centralblatt für Chirurgie, 1887.
[7] Lancet, 1893. [8] Therapeutic Gazette, Oct. 16, 1893.

periments upon animals have been practically verified upon man, they should be accepted with some reservation. From all the facts and observations now before us, we may draw the following practical conclusions:—

1. The inhalation of any anæsthetic substance is not entirely free from danger.
2. Chloroform is a safe anæsthetic when skilfully administered.
3. Death is usually from respiratory failure, providing that the heart is physically and functionally healthy (a condition which is not unfrequently indeterminable).
4. Death from circulatory depression—vasomotor or cardiac, or both—may occur, but is usually preceded by disturbance of respiration.
5. Both the respiration and circulation should be watched, but of the two the former is probably the better criterion.
6. Prolonged, profound, or oft-repeated anæsthesia may produce serious changes in the nervous system and also in the myocardium, which may be manifested, either definitely or indefinitely, for days or even weeks after anæsthesia is recovered from.

ADMINISTRATION OF ANÆSTHETICS.

PREPARATION OF PATIENT.—From a medico-legal standpoint it is best to inform the patient or his friends, in the presence of a third party, that the inhalation of any anæsthetic is attended with some danger. A careful examination of the heart, lungs, and urine should be made before the anæsthetic is selected. The patient should not take any food, excepting beef-tea or clear bouillon, for at least six hours before an anæsthetic is given. Feeble and nervous patients, as well as drunkards, should be given some stimulant, or morphine with atropine hypodermically, within one-half hour before inhalation is begun. The patient's clothes should be loose, and so arranged as to admit of ready exposure of chest and abdomen. The patient should be told what sensations to expect. The eyes should be covered with a damp cloth to prevent irritation of fluid or vapor. If chloroform is to be used, the face may be protected by simple cerate or vaseline. Fear should at all times be allayed by kindly reassurances, and by the avoidance of all reference to the operation until complete anæsthesia is obtained.

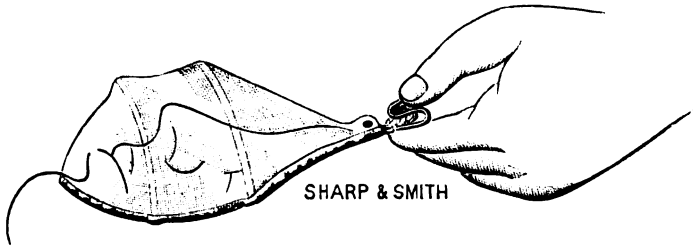
ANÆSTHETIST.—Whatever the agent, the anæsthetist should be, if possible, one skilled in its use, and he should give his whole attention to its administration. Ether should be preferred to chloroform unless the anæsthetist is skilled in the use of the latter. In addition to having a pure anæsthetic, he should have, at least, a pair of forceps, a hypodermic syringe, solutions of strychnine and atropine, tincture of digitalis, or digitalin, aromatic spirits of ammonia, and whiskey. It is well also to have an additional anæsthetic substance at hand.

ETHER.—It is necessary to exclude all air to produce complete anæsthesia with ether, and hence a cone with impervious walls should be used. Glover's, Allis's, Ormsby's, and other inhalers are excellent in construction, but are, as a rule, cumbersome and often not at hand.

An extemporized cone of pasteboard, or any firm substance, surrounded by a towel so as to leave a space for evaporation, is efficient, clean, and always readily made. At first, the cone should be held several inches from the patient's face, but after the nasal and faucial mucous membranes have been anæsthetized, its close application should be allowed, when rapid inhalation of concentrated ether vapor can be secured, thus producing narcosis quickly and safely.[1] After complete anæsthesia has been produced, the inhaler should be removed during every sixth or eighth inspiration and expiration.[2] Death occurs from paralysis of respiration; therefore the respiration and the color of the face should be watched, and since the diaphragm is the first respiratory muscle to stop acting, it is advisable to notice the abdominal movements. Complete anæsthesia is indicated by a contracted pupil[3] and the absence of the act of deglutition.[4] *Etherization by the rectum* is, to say the least, a dangerous method, and as yet is most unsatisfactory.[5]

CHLOROFORM.—This must always be greatly diluted with air. Even five per cent. of chloroform is dangerous. The air surrounding the patient should be dry, and the temperature should be above 60° F.[6] The stages of narcotism are prolonged, and syncope is more fatal, in a moist atmosphere.[7] Chloroform should be administered by the open method, and very slowly at first. The simple inhaler of Esmarch (Fig.

Fig. 1594.



Esmarch's Inhaler.

1594), which consists of a wire frame with a gauze covering, or the canvas cone of Lawrie,[8] is the best, as the apparatus itself does not require attention, and always admits a large amount of air. Any possible interference with respiration should be prevented by loose clothes, position, etc. Struggling, choking, and holding the breath should be avoided by holding the inhaler farther from the face.[9] The inhaler should be removed during an act of gasping following struggling, etc., as a dangerous dose might be taken in at such a time. After tolerance is acquired and the first stage past, the administration should be pushed quickly into the third stage of anæsthesia. The more bounding the pulse, the more rapidly is chloroform absorbed, and, hence, less is required. When administered near a gas flame, I as well as others[10] have noted that chloroform becomes decomposed and causes irritation

[1] Medical Record, 1889. [2] Buxton, Anæsthetics.
[3] La France Médicale, 1887. [4] Practitioner, 1887.
[5] Buxton, Anæsthetics. [6] Asclepiad, 1892.
[7] Ibid., 1892. [8] Therapeutic Gazette. [9] Ibid.
[10] Lancet, 1889; Medical Press and Circular, 1889; Berliner klin. Woch., 1889; Practitioner, 1889.

of the nose and throat in all who are present, and sometimes produces nausea and serious disturbances of respiration. Complete anæsthesia is indicated by an insensitive cornea, stertorous but rhythmical breathing, or muscular relaxation. The presence of either should cause stoppage of inhalation.[1] We should watch, (1st) the rhythm and depth of respiration, preferably the abdominal, (2d) the pulse, and (3d) the pupil. Anæsthesia should be complete before the operation is begun, so as to lessen the liability to syncope from reflex inhibition of the heart.

Additional evidence has been presented that anæsthesia can sometimes be produced in children during sleep.[2]

NITROUS OXIDE.[3]—1. Have the mouth or face piece fit accurately, and hold the nose, so as to exclude all extraneous air. 2. The patient should take a few deep inspirations before the gas is turned on. 3. To avoid struggling and the use of large quantities of gas, and to promote profound narcosis, turn the gas on toward the end of a long expiration. 4. Slight pressure on the bag facilitates the action of the gas. 5. Dropping of the chin indicates full narcosis. Hillisher[4] has administered nitrous-oxide gas with from ten to fifteen per cent. of oxygen to 2901 patients, producing peaceful sleep for a long time, and he considers it the ideal anæsthetic. He has devised an apparatus for the definite mixture of the gases, and claims to have eliminated the necessity of pressure, which according to the extensive experiments of Paul Bert was essential.

BROMIDE OF ETHYL.—This should be administered on an open inhaler, in drop doses for the first few seconds, and then the full dose should be applied close to the mouth. Anæsthesia usually occurs in from fifty to sixty seconds.

ACCIDENTS OF ANÆSTHESIA.

ASPHYXIA.—Asphyxia may result from the following causes: 1. Muscular rigidity of the jaws, which can be overcome by forcibly holding the mouth open. Spasm of the respiratory muscles probably never leads to a fatal result.[5] 2. Mechanical closure of the laryngeal opening by the epiglottis,[6] or falling backward of the tongue, which may best be relieved by flexion of the neck, with moderate extension of the head and elevation of the jaw by means of the fingers placed behind its angles.[7] 3. Accumulation of mucus, which must be removed by sponges, or by turning the head to one side. 4. Presence of foreign bodies, as, for instance, teeth, blood clot, masses of new growth, sponges, etc., which should be removed, if possible, through the mouth, but otherwise by tracheotomy. Blood may be removed by suction with a suitable syringe. 5. Respiratory paralysis from over-dosage. If the face is flushed and cyanotic, the failure is respiratory and the head should not be lowered, while if the face is pale, the failure is primarily cardiac and the head then should be lowered.[8]

[1] Lawrie, Therapeutic Gazette.
[2] Buxton, Anæsthetics; Medical Record, 1890.
[3] British Medical Journal, 1892.
[4] Allg. Wien. med. Presse, 1889.
[5] McCallum, Medical News, 1892.
[6] Buxton, Anæsthetics.
[7] Martin and Hare, Annual of Univ. Med. Sciences, 1890.
[8] Hare, Practical Therapeutics.

Artificial respiration should be carefully performed by Sylvester's or Kelly's method,[1] at the rate of from sixteen to twenty movements to the minute, and it should invariably be commenced by an expiratory effort,[2] so as to avoid further absorption of the anæsthetic, or, if possible, the vapor should be sucked out of the lungs before inspiration is performed. Artificial respiration should be maintained for at least forty-five minutes, as patients have recovered after being apparently dead for an hour.[3] During the attempt at restoration the respiratory tract should be maintained unobstructed as directed above. A dash of cold water, or better ether, on the abdomen and chest may cause reflex inspiration,[4] as may the general application of the electric current to those surfaces.[5] Other forms of irritation, and especially dilatation of the internal anal sphincter, may be successfully employed at times.

The hypodermic use of strychnine and atropine, and, if the emergency be great, the use of ammonia by intravenous injection of the weaker watery solution (Aqua ammoniæ U. S. P.) into the leg, are very useful. Frictions and hot applications are also indicated.

SYNCOPE.—Syncope rarely occurs during etherization, but does sometimes occur during chloroform inhalation. (*a*) *In the first stage*, it is suddenly manifested by fluttering or stopping of the pulse, extreme pallor, sudden wide dilatation of the pupils, and cessation of respiration. It is usually fatal. (*b*) *In the later stage*, there is usually more warning given, by disturbed respiration, pallor, weakened pulse, cessation of hemorrhage, and dilatation of the pupils. When syncope is threatened or has occurred, the surgeon should remove the inhaler, lower the head, and, if necessary, maintain *artificial respiration* as above described. Direct *compression of the heart* by pressing the hand deeply under the costal cartilages seems to have been efficient,[6] and is easily performed during artificial respiration. Deep and rapid pressure in the precordial region has proven successful in several instances, with or without artificial respiration.[7] *Strychnine* is probably the best stimulant to administer under these circumstances. Ether may be used hypodermically with advantage, at times, as may also whiskey, digitalis, and ammonia, but if the circulation has stopped their employment appears useless. Nitrite of amyl is positively contra-indicated,[8] except in the later stages of narcosis, or after great loss of blood, when a single whiff may do some good.[9] *Auto-transfusion*, by elevating the limbs and applying constrictors for from three to five minutes, has been of use.[10] Babroff[11] recommends very highly the injection of from 25 to 225 grammes of a 6–1000 *saline solution* into the subcutaneous tissues, as soon as any evidence of respiratory or cardiac embarrassment occurs. The greater the loss of blood or the anæmia, the larger the amount to be injected. *Heat and sinapisms to the precordium* are useful. *Puncture of the heart*, as proposed by Watson,[12] *faradization and galvani-*

[1] British Medical Journal. [2] Murray-Aynsley, Annual of Univ. Med. Sciences, 1893.
[3] Hare, Practical Therapeutics. [4] Münchener med. Woch., 1889; Medical Age, 1889.
[5] Hare, Practical Therapeutics. [6] Iliffe, British Medical Journal, 1892.
[7] König, Berliner klin. Woch., 1892; Sinclair, British Medical Journal, 1892.
[8] Babroff, Kirurgitcheskaia Latopis.
[9] Hare, Practical Therapeutics; Buxton, Anæsthetics.
[10] Babroff, Kirurgitcheskaia Latopis. [11] Ibid., 1891.
[12] New York Med. Journal, 1887.

zation of the heart and of the phrenic nerves, and the *injection of ether* in ether narcosis, are unscientific and deserve condemnation.[1]

EPILEPTIC SEIZURES.—Nothing can be done during such seizures except to protect the patient's tongue, and restrain him from doing himself an injury.

AFTER-EFFECTS OF ANÆSTHESIA.—*Temperature.*—This is appreciably lowered by etherization, and hence it is advisable to supply artificial heat and to keep the patient well covered.

Nausea and Vomiting.—These conditions often prove troublesome, and sometimes intractable. No specific treatment has as yet been devised, but the following measures have been found most useful. The patient should maintain the recumbent position and abstain from food for three or four hours after anæsthesia. Hot water in teaspoonful doses is frequently useful. Small quantities of ice, and also iced champagne, are quite generally used. Ice with small doses of aconite is advised by Hare.[2] Dr. Ochsner, of Chicago, has had nearly uniform success in controlling vomiting after anæsthesia by administering an ounce of castor oil in the foam of ale. It is important to give only the foam of the ale, the carbonic acid gas of which probably acts as a local anæsthetic until the oil removes the mucus from the stomach. Sinapisms applied over the epigastric region are sometimes beneficial. In plethoric, bilious persons, small doses of calomel are occasionally useful. Nausea alone can be relieved by minim doses of tincture of nux vomica, given in hot water every ten minutes.[3] Britton[4] recommends four or five drops of spirit of chloroform, with two or three drops of the vinegar of opium, as the most efficient remedy in ether nausea.

Hiccough.—This may be relieved by an infusion of mustard (℥i. added to f℥iv. of boiling water) taken in teaspoonful doses.[5] Morphine hypodermically is also useful.

Hysteria.—Hysterical seizures may occur, but are of short duration and do not require treatment.

Insanity.—Various forms of insanity may follow anæsthesia in predisposed persons,[6] and should be treated upon general principles. I had once three cases within a single month, in which insanity developed after anæsthesia for herniotomy, on the fourteeenth, twelfth, and fourth days respectively. The last two cases recovered under general treatment, and the first underwent improvement.

Jaundice.—This condition occasionally follows chloroformization, and should be treated as catarrhal jaundice.

Albuminuria and Glycosuria.—These conditions may follow both ether and chloroform anæsthesia, and while usually temporary after the latter, they may prove serious when caused by the former, and should be treated upon general principles.

[1] Hare, Practical Therapeutics; Buxton, Anæsthetics; Babroff, Kirurgitcheskaia Latopis, 1891; Annual of Universal Med. Sciences, 1893.

[2] Practical Therapeutics.

[3] Buxton, Anæsthetics.

[4] Annual of Universal Med. Sciences, 1892.

[5] Buxton, Anæsthetics.

[6] Savage, Brit. Med. Journal, 1887; Bull, Annual of Univ. Med. Sciences, 1888; Brophy, ibid., 1888; Boston Med. and Surg. Journal, 1889; American Journal of Med. Sciences, 1890.

Mortality from Anæsthetics.

In addition to the statistics given by Lyman, in Vol. I., it may be said that Hunter McGuire[1] states that he saw 28,000 chloroform administrations during the War of the Rebellion, without a death, and that Lawrie[2] reports 45,000 administrations, also without a death. T. Brown Henderson,[3] on the other hand, gives the statistics from St. Bartholomew's Hospital, as follows: Chloroform, 12 deaths in 17,666 administrations (1 in 1472); ether, 1 in 7493; gas and ether, 1 in 12,807. Julliard[4] collected 524,507 chloroform administrations, with 161 deaths (1 in 3258), and 1 death in 14,987 etherizations. Macewen, Macleod, and Buchanan, of Glasgow,[5] record 34,000 chloroform administrations with but three deaths (1 in 11,000), while Ollier[6] reports 29,500 etherizations without a single fatal result. Gürlt,[7] of Berlin, reported to the last German Surgical Congress the statistics from 62 operators, showing 109,196 cases of anæsthesia, with 39 deaths, or an average of 1 in 2800, divided as follows: Chloroform, 94,123, with 36 deaths (1 in 2614); ether, 9431, without a death; ether and chloroform, 2891, with one death; ether and alcohol, 1381, with no death; bromoform with ethyl-bromide, 2151, with one death; pental, 210, with one death. In the Medical News of October 29, 1892, an extensive array of statistics is presented, comprising reports from 42 sources and showing 638,461 administrations of chloroform, with 170 deaths (1 in 3749), and 300,157 etherizations, with 18 deaths (1 in 16,675). It is also reported that Dr. Rabotz has administered ether 150,000 times, without any death. Several deaths and a large number of cases which presented serious symptoms have occurred from the hypodermic use of cocaine.

It should be noted that the reports of McGuire, Nussbaum,[8] and Lawrie, comprising 113,000 chloroformizations without a single death, were, in the first and second instances, of administrations in military practice, which should be received with some reserve, as it is very difficult to fairly weigh all the causes of fatal results under such circumstances, while in the last instance they were in a hot, dry climate, under conditions most propitious for the safe administration of chloroform. Statistics compiled, as has been the custom, from so many sources, are at best unreliable, and since but a comparatively small proportion of the deaths and even a smaller proportion of the administrations are ever recorded, their practical uselessness is apparent. To be of value, the cases for the administration of the different agents should be carefully selected, and the anæsthetic should be used by skilled and unbiased operators. Even then it should be remembered that the results will naturally vary considerably. The Scotch and German statistics are undoubtedly the most reliable at hand, and the difference in the ratios given is probably best accounted for by different methods of administration. We are informed that the Germans are given to pushing chloroform narcosis, which may account for their high mortality rate; while the ratio of the leading Scotch surgeons (1 in 11,000) was doubtlessly

[1] Journal Amer. Med. Assoc., 1887.
[2] Lancet, 1890.
[3] Glasgow Med. Journal, 1890.
[4] Buxton, Anæsthetics.
[5] Ibid.
[6] Revue de Chirurgie, 1893.
[7] Centralblatt für Chirurgie, 1892.
[8] Bulletin de l'Acad. de Méd. de Paris.

attained by very careful selection and administration, and is probably the most favorable award that can be made to chloroform. The ratio of fatal ether narcosis as given by Lyman in Vol. I. (1 to 23,000) is, according to Julliard and Buxton,[1] probably too low. It should be remembered, however, that the vast majority of deaths from ether narcosis have occurred in cases of strangulated hernia, carcinoma with starvation, etc., conditions in which the power of resistance has been very greatly reduced. The statistics of the other substances, either alone or in combination, are so meagre and unreliable that it is impossible to express their comparative dangers, excepting that it should be remembered that nitrous oxide has been administered millions of times with less than ten recorded deaths, and that the hypodermic use of cocaine for local anæsthesia is attended with considerable danger.

CHOICE OF ANÆSTHETICS.

The choice of an anæsthetic depends upon the condition of the patient, the necessities of the operation, and the safety of the agent. No argument has been advanced to successfully change the judgment heretofore expressed as to the relative safety of ether and chloroform. We must, therefore, conclude that generally ether is the safest anæsthetic, and especially as far as the immediate effects are concerned. The condition of the patient and the exigencies of the operation must, however, always be taken into consideration.

ETHER.—Ether is generally to be preferred under the following conditions: 1. When the operator must employ an unskilled anæsthetist. 2. In collapse or extreme prostration, as in cases of prolonged suppuration with a hectic or anæmic state, collapse following loss of blood, etc., since it stimulates the heart and but little of the anæsthetic is required.[2] 3. In heart disease the dangers of any anæsthetic are increased, but ether is to be preferred to chloroform. In uncomplicated mitral regurgitation, ether can be given as in any ordinary case.[3] 4. In persons who are free from pronounced pulmonary or renal disease.

CHLOROFORM.—While chloroform is more dangerous than ether, it is comparatively safe when skilfully administered to persons not affected with organic or functional cardiac incompetency. It should be preferred in the following conditions: 1. In hot climates, where ether is usually inapplicable, and where a free circulation of dry and warm air increases the safety of the patient. 2. When a large number of persons are to be anæsthetized. 3. In cases of Bright's disease. 4. In cases of aneurism and marked atheroma of the blood-vessels, where the struggling and vascular stimulation of ether might cause rupture. 5. In cases of obstruction in the respiratory tract, or acute or pronounced pulmonary disease, as bronchitis, pneumonia, phthisis, or any other condition productive of dyspnœa. 6. In cases requiring the use of the thermo-cautery about the head, or in operating near an open fire. 7. When the circulation is not disturbed by fatty degeneration or valvular disease of the heart. 8. Only when a competent anæsthetizer is at hand.

[1] Buxton, Anæsthetics. [2] Ibid.; Lancet, 1888. [3] Ibid., 1889.

9. In children and adults who already have bronchitis or are known to bear ether badly. 10. In weak and sickly persons, who, as a rule, take chloroform with less danger than the strong and robust, because they struggle less, making the strain on the heart less. 11. In patients who have taken food within four hours. 12. In obstetrical cases.[1]

NITROUS OXIDE.—This agent is especially useful in dental surgery and in minor operations requiring anæsthesia for but a few moments, and also in the extremely weak. Its administration preparatory to the use of, or in combination with, ether, will avoid the struggling and excitement caused by that agent, but as the combined administration requires a special and somewhat cumbersome apparatus,[2] its use in this manner must of necessity be limited to hospital practice.

ETHYL BROMIDE.—This agent is indicated in short operations, but its instability, impurities, and frequent substitution by ethylene bromide, which is very dangerous, render its effects uncertain and its use unsafe.[3] It is, however, held in favor by a number of prominent European surgeons,[4] and by a few Americans.[5]

SELECTION OF ANÆSTHETIC FOR SPECIAL DEPARTMENTS OF SURGERY.—*Brain Surgery.*—Chloroform, with morphine either before or during anæsthesia, is to be preferred, as ether causes too much vascular excitement in the brain. The morphine will prolong the anæsthesia with very little chloroform.

Ophthalmic Surgery.—Cocaine is very extensively used. Ether and chloroform are also extensively employed; the former seems the safer, but the latter facilitates the operation by producing absolute immobility of the patient.

About the Mouth, Jaws, and Respiratory Tract.—Chloroform is the most satisfactory, since the inhalation of a small amount at intervals suffices to maintain complete anæsthesia. By extending or turning the head to one side, the entrance of blood or other substances into the larnyx can be prevented. Senn and some other surgeons prefer to operate about the mouth during partial—"talking"—anæsthesia, secured by the administration of morphine with whiskey to semi-intoxication, when the patient will spit out the blood, etc., when commanded so to do.

Dental Surgery.—Nitrous oxide gas alone or with ether is the safest and most convenient anæsthetic.

Thoracic Surgery.—The choice will depend upon the symptoms and general condition of the patient (see Ether and Chloroform).

Abdominal Surgery.—Chloroform should generally be preferred, because it relaxes the abdominal walls most completely, and because the liability to coughing, struggling, and vomiting is not as great as with ether, which, however, is preferred by many operators.[6] After the incision has been carried through the parietes, only a small degree of narcotism is required.

Rectal Surgery.—The narcosis must be very profound and, as a rule, ether is considered the safest anæsthetic.

[1] See Lyman, in Vol. I. [2] See Fig. 39, Vol. I., page 417.
[3] Lyman, Vol. I.; Annual of Univ. Med. Sciences, 1890.
[4] Annual of Univ. Med. Sciences; Vrach, 1891; Zeitschrift für Therapie.
[5] Medical News, 1892. [6] Buxton, Anæsthetics; British Med. Journal, 1892.

HYPNOTISM.—The following operations have been reported as having been performed during hypnosis: Amputation of the breast, by Cloquet, in 1829; amputation of the leg, by Loysel, in 1844; of the arm, by Joly, in 1845; of the thigh, by Guérineau, in 1859.[1] More recently Mesnet[2] has performed anterior colporrhaphy during hypnosis, and Roth has reduced a dislocation of the humerus;[3] Hafftner is reported[4] to frequently produce this state by holding the mask before the patient's face, and soothingly directing him to go to sleep.

ANÆSTHETIC SUBSTANCES.

TRIMETHYLETHYLENE—C_5H_{10}—*Pental.*—This is an impure amylene,[5] the use of which has been revived within the past two years. Gürlt records 210 administrations with 1 death, while Höllaender[6] reports 900 narcoses by its means for minor operations with no fatality. While regarding it as the best anæsthetic for short operations, he admits the occurrence of dangerous symptoms, and does not produce any evidence to show its superiority over older and safer anæsthetics. Wood and Cerna,[7] and Chalab,[8] consider it very dangerous.

DICHLOROMETHANE—*Methylenic Chloride, Methylene Bichloride.*—Favorable reports are occasionally received of the use of this agent. Trélat[9] declares that the methyl chloride of Sir Spencer Wells is a mixture of chloroform and methylic alcohol, 4 to 1, and that it does not decompose by exposure to air or light. Used by means of a spray, methylene chloride produces local anæsthesia, which is probably due to freezing of the part by rapid evaporation.[10] The danger of sloughing may be prevented, according to Bardet,[11] by painting the surface with glycerin.

CHLORALAMIDE—$C_6H_8O_2N$.—This is a colorless, crystalline, and slightly bitter substance, with a melting point of 115° C. (239° F.). It is a compound formed by the addition of formamide to anhydrate of chloral. It is soluble in 9 parts of water and 1½ parts of alcohol, and does not decompose in either solution. Its action is similar to that of chloral, being a cerebral and spinal depressant, but it does not so considerably depress the circulation. In addition to being a potent hypnotic, it is credited with being an efficient analgesic. It is administered in from ten-grain to thirty-grain doses, and the resulting sleep usually lasts from five to eight hours.

PARALDEHYDE—$C_6H_{12}O$.—This is a colorless liquid, having a disagreeable odor and burning taste, with a boiling point of 124° C. (255° F.), and a sp. gr. of 0.998. It is readily soluble in cold water and alcohol. It acts as a nerve sedative, and is principally used as an hypnotic and

[1] Practitioner, 1889. [2] Bulletin de l'Acad. de Méd. de Paris, 1889; Practitioner, 1889.
[3] Provincial Med. Journal, 1889; Correspondenz-Blatt für Schweizer Aerzte, 1889.
[4] Correspondenz-Blatt für Schweizer Aerzte, 1889.
[5] Hare, Practical Therapeutics. [6] Dental Cosmos, 1893.
[7] Ibid., 1892. [8] International. klin. Rundschau, 1892.
[9] Bulletin de l'Acad. de Méd. de Paris, 1889; Cincinnati Lancet-Clinic, 1889.
[10] Asclepiad, 1889. [11] Annual of Univ. Med. Sciences, 1890.

antispasmodic. Death from its use occurs by respiratory failure. It is administered in large doses (from 30 to 60 grains) well diluted, and it is necessary to repeat the dose at short intervals.

TRIBROMOMETHANE—$CHBr_3$—*Bromoform.*—This substance is analogous to choloroform and has similar anæsthetic properties. It boils at from 147° to 151° C. (296.6° to 308.8° F.) and is soluble in alcohol and ether. It is produced by the action of bromine upon equal parts of methylic alcohol and caustic potassa. It is a colorless, limpid liquid, with a sweet taste and an agreeable odor. When applied locally it is a potent antiseptic. It is an antispasmodic and analgesic. Its use as an anæsthetic has been limited. Gürlt reports 2151 administrations of bromoform with ethyl bromide, with one death. When given by the mouth it should be diluted with alcohol, or suspended in syrup of acacia.

DIETHYL-DIMETHYLMETHANE—$C_7H_{16}S_2O_4$—*Sulphonal.*—This is a colorless, odorless substance, melting at 125° C. (257° to 259° F.). It is made synthetically by the interaction of anhydrous mercaptan and anhydrous acetone in the presence of hydrochloric acid gas. It is soluble in alcohol and ether, and sparingly so in cold (1 to 100) and hot water (1 to 20). Its chief property is that of an hypnotic, and as such it is administered in from fifteen-grain to thirty-grain doses. Its action is probably exerted upon the higher nerve centres.[1]

LOCAL ANÆSTHETICS.

COCAINE.—Cocaine is the alkaloid derived from the erythroxylon coca. When administered in medicinal doses it is a respiratory, cardiac, and cerebral, as well as muscular stimulant. In poisonous doses it produces cerebral convulsions and cardiac failure. When applied locally it paralyzes the sensory nerves. The hydrochlorate of cocaine is principally used, in the strength of from a two-per-cent. to a ten-per-cent. solution, which if prepared with boric acid and distilled water remains unchanged for a long time. About the eye and the mucous membrane of the nasal and pharyngeal cavities, a two-per-cent. or four-per-cent. solution is efficient, while in the vagina and rectum a ten-per-cent. solution is necessary. It is especially useful in ophthalmic and nasal surgery, in amputations of fingers, and in other minor operations where the circulation can be controlled. It is not readily absorbed by the skin or by a bleeding surface, and must be used hypodermically when such parts are concerned. In operations about the fingers a constrictor should be placed about the part, so as to interrupt the circulation, either before or preferably just after the injection of a solution of from four to eight per cent. When the operation has been completed the ligature should be intermittently relaxed, so as to prevent the drug from entering the circulation suddenly; this may also be accomplished by encouraging slight bleeding from the wound. Cocaine has been successfully used in a number of major operations,[2] such as amputation, lithotomy,

[1] Hare, Practical Therapeutics.

[2] Boston Med. and Surg. Journal, 1890; China Medical Missionary, 1890; New England Med. Monthly, 1892.

litholapaxy, herniotomy, laparotomy, etc., but since several deaths have occurred from its use, it should be looked upon as a dangerous anæsthetic, unless the drug can be confined and its entrance into the circulation graduated. Its effect upon different individuals varies greatly, and it should therefore be used cautiously, and the patient should be watched for some time after its systemic diffusion. In operations involving the skin, the drug should be injected into the derma itself, and not beneath it. Schleich[1] suggests a 1 to 10,000 solution in a two-per-cent. salt solution for intradermal injection, and declares that it is efficient and absolutely safe.

Tropa-Cocaine (*Tropsin*).—Under this name Chadbourne[2] calls attention to a new coca base. It is a benzoyl-pseudo-tropein, made synthetically, and is a powerful anæsthetic. A three-per-cent. solution of the hydrochlorate in a weak saline solution is employed, and it is claimed that it is more active, less irritating, more stable, and less than half as toxic as cocaine.

Cocaine Phenate.—This combination was produced by Von Oefele,[3] and has been favorably reported upon by Veasey.[4] The employment of these preparations has not been sufficiently extensive to enable one to form any definite opinion as to their merits.

ETHYL CHLORIDE.—When this substance is sprayed upon the surface of the body, it produces local anæsthesia by freezing. It is kept in a compressed form, sealed in glass tubes.

OTHER LOCAL ANÆSTHETICS.—Many substances have been added to the list of local anæsthetics during the past few years, but upon careful investigation most of them have been proven to be either inert, less efficient than cocaine, or too irritating for use, or to be proprietary preparations in which cocaine is found. *Stenocarpine*, or *Gleditschia triacanthus*, is an efficient local anæsthetic which belongs to the last class.[5] *Drumine*, proposed as efficient, was found absolutely inert by Ogston.[6] *Erythrophlœin* produces anæsthesia of the cornea, but its mode of action is in dispute. It does not produce anæsthesia when injected.[7] Anæsthesia has been produced by instilling from two to three drops of an aqueous solution of *strophanthus*[8] into the eye. The action is slow, but the effect quite prolonged. Intraocular pressure is greatly increased.

Many other substances have a local anæsthetic effect upon the tissues,[9] as, for instance, ammonium bromide and sulphate, iron salts, acetate of lead, resorcin, antipyrine, drugs of the digitalis group, and the essential oils; the latter act by destroying the nerve ends and by causing adjacent irritation. Styptics and caustics are, as a class, anæsthetic, as are salt solutions and even distilled water.

[1] La Semaine Médicale. 1892.
[2] British Med. Journal, vol. ii., 1892.
[3] Merck's Bulletin, 1891.
[4] Medical News, 1893.
[5] Ibid., 1887.
[6] British Med. Journal, 1887.
[7] Annual of Univ. Med. Sciences, 1889.
[8] Ibid., 1888.
[9] Ibid., 1889.

NOTE TO PAGE 182.

Gurlt[1] reports for 1893 and 1894 52,384 inductions of anæsthesia with 21 deaths (1 in 2494), divided as follows: Chloroform, 33,080 administrations with 17 deaths (1 in 1946); ether, 11,668 administrations with 2 deaths (1 in 5834); and Pictel's glacial chloroform, 3182 administrations with 2 deaths (1 in 1591). These statistics added to those of the preceding three years, as quoted on page 182, give chloroform a ratio of 1 death in 2647, and ether of 1 in 13,160.

[1] Verhandlungen der Deutschen Gesellschaft für Chirurgie.

AMPUTATIONS.

BY

JOHN ASHHURST, JR., M.D.,

BARTON PROFESSOR OF SURGERY AND PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF PENNSYLVANIA, SURGEON TO THE PENNSYLVANIA HOSPITAL, ETC.

OPERATION AND DRESSING OF THE STUMP.

SINCE the appearance of the Article on Amputations in the first volume of this work, I have, in common with other surgeons, adopted what is known as the "antiseptic method," in a simplified form, in the dressing of stumps, and during the last seven years have employed this method in all the amputations which I have had occasion to perform, as well as in other operations. I have not used the antiseptic spray, and indeed it is now, I believe, universally abandoned, and I have not for several years used antiseptic irrigations during the progress of the operation, believing them to be quite unnecessary, and not unattended with danger from the risk of increasing the shock by chilling the patient's surface, since even warm solutions by evaporation reduce the bodily temperature. Indeed, I attribute much importance to the maintenance of heat during the operation, and in cases, as of multiple amputation, in which there is likely to be much depression, I have hot cans or hot-water bags placed on the operating table in proximity to the patient's trunk, and am confident that I have saved lives by the adoption of this precaution.

For the same reason (the fear of chilling the patient) I object to the use of ether in the preliminary cleansing of the part on which the operation is to be performed; it is quite sufficient to have it carefully shaved, rubbed with oil of turpentine, and thoroughly scrubbed with hot soapsuds, and finally well washed with a hot 1-2000 solution of corrosive sublimate. The operation is then proceeded with, and no further washing or irrigation is necessary until the vessels have been tied and the surgeon is ready to close the wound. In this view I am sustained by the recent utterances of Sir Joseph Lister himself, who declares that no fear need be entertained of germs that may be in the air, and that those only are deleterious which are on the surface of the patient's body, or which may be introduced by the surgeon's hands or instruments. The inventor of the antiseptic method has latterly returned to his first love, and relies for the cleansing both of the patient's body and of the operator's hands upon a five-per-cent. (1-20) solution of carbolic acid, and declares that by its employment it is sometimes possible even to dispense with soap and water; but, for my own part, I prefer the sublimate to the carbolic solution, except for use with the instru-

ments, sutures, etc., and while I do not practise the complicated washings recommended by some surgeons both at home and abroad—washings which in their multiplicity and complicated character surpass those of the ancient Pharisees—yet I believe in the necessity of ordinary as well as of antiseptic cleanliness, and have an old-fashioned respect for soap and the nail-brush. During the operation the limb to be amputated is kept surrounded with towels wrung out of antiseptic (1-2000 sublimate) solution, but these are kept from chilling the patient by being spread over blankets protected by India-rubber sheeting.

I have not any changes to suggest in the *technique* of the operation of amputation in general, except that in employing catgut ligatures, which I prefer to silk under ordinary circumstances, I find that the first turn of the reef-knot is apt to slip before the second can be tied down upon it, and I therefore begin with a surgeon's knot (see Fig. 139, Vol. I., p. 582), which keeps its place very well, and then secure it by a second knot which fixes it permanently. This cannot be done with very thick catgut, and with that is unnecessary, since then the first turn of the reef-knot can be drawn so tightly as to prevent slipping; but with the thickness of gut employed for ordinary ligatures this modified knot will be found very satisfactory. For ligating the majority of vessels in an amputation I use catgut prepared with juniper-oil and alcohol, but for the main artery in a large amputation—as through the thigh, or at the shoulder-joint—chromicized catgut is preferable because more enduring. For suturing the stump I still employ a metallic stitch, usually of silver wire, which for large wounds I prefer to any other material; for small amputations, as of the fingers, I sometimes use silkworm gut, or even fine black silk.

Drainage-tubes of India-rubber are, I think, of great value in the treatment of stumps, though I feel bound to say that in an amputation of the thigh which Professor Esmarch did at my Clinic some years ago by his circular, single-incision (*einschnitt*) method, and in which he closed only the centre of the wound, leaving both ends open, without drainage-tubes, healing took place as rapidly and as perfectly as could be desired. But I think the use of the tube is a safe precaution, and I commonly place one of large calibre (one is usually sufficient) across the face of the stump, cutting it on a level with the skin, and securing both its extremities by safety-pins. In circular amputations I sometimes bring out one or both ends of the drainage-tube through perforations of the cuff above the level of the incision, which is then closely sutured.

For the dressing of stumps I employ protective, a deep and a superficial dressing, a moderately thick layer of cotton, and a roller bandage. The use of iodoform in a fresh wound I think objectionable as being both unnecessary and frequently irritating. I do not pretend to say that the particular form of dressing which I am about to describe is better than those employed by other surgeons, and indeed I believe that if the principles of asepticism—that is, perfect cleanliness—and if the avoidance of irritation are carried out, the special articles used are a matter of indifference; but this dressing is simple and easily applied, and I can recommend it as entirely satisfactory. The *protective* (Lister's) should be large enough to cover the entire line of the wound, with a margin at each end and on both sides of at least three-quarters

of an inch, and before being applied is dipped in the 1-2000 sublimated solution; it should be closely adjusted, and slit at its extremities to enable it to be fitted around the ends of the drainage-tube, below the safety-pins. The object of the protective is to keep the deep layers of gauze from adhering to the wound, and to protect the latter from the irritating effect of the corrosive sublimate with which the gauze is impregnated. The *deep dressing* consists of at least eight layers of sublimated gauze, of ample dimensions, wrung out of the hot 1-2000 solution, not that it may be used as a wet dressing, but simply that its aseptic quality at the moment of application may be insured; it is carefully folded around the stump in the manner described in Vol. I., page 605. The *superficial dressing* contains an equal number of layers of gauze, cut of still larger size, and is applied dry; between its outer layers is inserted a sheet of *mackintosh* cloth, or some substitute, which again is wrung out of the hot 1-2000 solution immediately before adjustment. In hospital practice, I employ instead of the mackintosh, from motives of economy, a tough water-proof paper, made for the packing of butter for transportation, which becomes soft and flexible when dipped in the hot solution, and which answers the intended purpose in every respect satisfactorily. The object of the mackintosh or water-proof paper is not, as is sometimes supposed, to keep the dressings moist, but to prevent blood or serum from the wound soaking through to the exterior — where it would come in contact with the air, and might undergo putrefaction—by interposing an impermeable barrier which forces the effused fluids to turn upon themselves, as it were, and saturate the whole thickness and extent of the dressings before they can reach the surface, and then only marginally and at a considerable distance from the wound. The superficial dressing is entirely surrounded with *sublimated cotton*, which, besides being antiseptic, serves to protect the stump from mechanical injury, and the whole is then secured with a firm and slightly compressing *bandage* which consolidates the various portions of the dressing, and keeps everything close and snug. This dressing may usually be allowed to remain undisturbed for five or six days, and sometimes much longer.

Fig. 1595.

Recovery after triple amputation. From a patient in the University Hospital.

STATISTICS.

In the Article in Vol. I., pp. 598 and 619, I gave statistics of multiple and single major amputations occurring in my own practice. Since the publication of that article I have with my own hands done 153 single, 2 triple, and 10 double amputations, some particulars of which I have included in the annexed tables. An analysis of these shows that the death-rate of my operations has slightly diminished in the single amputations, and has been materially less in those of a multiple character. This will appear from the following summary:—

TABLE SHOWING RESULTS OF 253 CASES OF SINGLE MAJOR AMPUTATION.

Part Involved.	First Series Cases 1-100.				Second Series. Cases 101-153.				Both Series.			
	Recovered.	Died.	Total.	Mortality Per cent.	Recovered.	Died.	Total.	Mortality Per cent.	Recovered.	Died.	Total.	Mortality Per cent.
Wrist	1	0	1	0.0	1	0	1	0.0	2	0	2	0.0
Forearm	13	5	18	27.7	14	0	14	0.0	27	5	32	15.6
Elbow	1	0	1	0.0	2	0	2	0.0	3	0	3	0.0
Arm	15	6	21	28.6	17	3	20	15.0	32	9	41	21.9
Shoulder	3	2	5	40.0	6	0	6	0.0	9	2	11	18.1
Ankle	2	0	2	0.0	3	0	3	0.0	5	0	5	0.0
Leg	22	3	25	12.0	35	9	44	20.4	57	12	69	17.4
Knee and knee-joint	2	2	4	50.0	8	9	17	52.9	10	11	21	52.4
Thigh	12	8	20	40.0	27	15	42	35.7	39	23	62	37.0
Hip	1	2	3	66.6	1	3	4	75.0	2	5	7	71.4
Aggregates	72	28	100	28.0	114	39	153	25.4	186	67	253	26.4

TABLE SHOWING RESULTS IN 23 CASES OF MULTIPLE AMPUTATION.

	First Series—11 Cases.				Second Series—12 Cases.				Both Series—23 Cases.			
	Recovered.	Died.	Total.	Mortality Per cent.	Recovered.	Died.	Total.	Mortality Per cent.	Recovered.	Died.	Total.	Mortality Per cent.
Double amputation	4	7	11	63.6	7	3	10	30.0	11	10	21	47.6
Triple amputation	0	0	0	0.0	1	1	2	50.0	1	1	2	50.0
Aggregates	4	7	11	63.6	8	4	12	33.3	12	11	23	47.8

These figures show for the single amputations a diminished death-rate of somewhat less than three per cent., and for the multiple amputations a gain of no less than 30 per cent. This great improvement I attribute to the general introduction into Philadelphia during this period of the ambulance system, which enables persons seriously injured by railway or machinery accidents to be put promptly under treatment and transported without risk of hemorrhage, and has thus been the means of saving many lives. Among the single amputations the greatest gain has been in operations in the upper extremity, with a slight improvement in the thigh amputations; but on the other hand the death-rate in amputations through the leg and at the knee and hip-joints has been greater than in my first series.

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.[1]

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			I. *Amputations at the Wrist.*				
101	Jan. 13, 1894	F. Adult. Laundress	Right hand burned and crushed by steam mangle	Oval method	Recovered	University	Secondary.
			II.—*Amputations through the Forearm.*				
102	May 17, 1884	M. 30. Operative	Right hand split by circular saw	Circular amputation, lower third	Recovered	University	Primary.
103	Oct., 1885	M. Adult. Brakeman	Left forearm crushed by railway train	do., upper third	"	"	Primary. Died 3 months after operation from perinephric abscess communicating with pleura and bronchi.
104	Oct. 21, 1886	M. 35. Brakeman	Right hand and wrist crushed between railway cars	do., lower third	"	"	Primary.
105	March 26, 1887	F. 80.	Sarcoma of right hand	do.	"	"	For disease.
106	June 24, 1887	M. Adult. Quarryman	Right hand blown off by explosion of dynamite	do., middle third	"	Pennsylvania	Primary.
107	Dec. 19, 1888	M. Adult. Laborer	Left hand blown off by explosion of blast	do., lower third	"	University	"
108	July 23, 1889	M. 30. Operative	Right hand and wrist crushed between cog-wheels	do., middle third	"	Pennsylvania	"
109	March 26, 1890	F. Adult.	Gangrene of right hand from burn received by falling against stove in epileptic fit	Posterior flap amputation	"	"	Secondary.
110	June 2, 1890	M. 25.	Right hand and wrist crushed between railway cars	Circular amputation, middle third	"	"	Primary.
111	July 8, 1890	M. 66. Laborer	Right hand crushed by fall of barrel of sugar	do., lower third	"	"	"
112	March 29, 1891	M. 21. Boxmaker	Gunshot wound of left forearm; radial and ulnar arteries severed	do., upper third	"	"	"
113	April 4, 1891	M. 30. Operative	Left forearm lacerated by carding machine	do.	"	"	"
114	Oct. 16, 1891	M. 16. Operative	Right hand crushed and lacerated by machinery	do., lower third	"	Children's	"
115	Feb. 17, 1894	M. Old.	Chronic disease of right wrist	do., middle third	"	University	For disease.

[1] In continuance of Table in Vol. I., page 618. The cases are numbered continuously.

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.—*Continued.*

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			III.—*Amputations at the Elbow.*				
116	June 28, 1888	M. Adult. Train-hand	Right forearm crushed between railway cars	Amputation by anterior and posterior flaps	Recovered	University	Primary.
117	March 9, 1892	F. Young.....	Osteo-sarcoma of forearm	Circular amputation	"	Pennsylvania	For disease. Died in 2 months after operation from secondary intrathoracic growth.
			IV.—*Amputations through the Upper Arm.*				
118	Oct. 23, 1882	M. 30. Train-hand	Right arm crushed by railway train	Circular amputation, middle third	Recovered	University	Primary.
119	June 7, 1883	M. 25. Train hand	Right arm crushed by railway train	Modified circular amputation, upper third	"	"	"
120	Sept. 13, 1883	M. 24. Brakeman	Secondary hemorrhage following compound fracture of right arm from railway injury	do.	Died	"	Secondary. Death in 4 hours from shock and hemorrhage.
121	Dec. 17, 1884	M. Adult. Brakeman	Traumatic gangrene of left arm following crushing injury by railway train	Circular amputation, upper third	Recovered	"	Intermediate.
122	April 1, 1886	M. 19. Telegraph Operator	Compound fracture of left humerus by railway injury. Rupture of brachial artery and vein	Modified circular amputation, upper third	"	"	Primary.
123	Nov. 27, 1886	M. Young adult	Recurrent caries after excision of elbow. Tuberculosis	Circular amputation, middle third	Died	"	For disease. Death in 8 days from tubercular meningitis.
124	Nov. 27, 1886	M. 45.	Contracted and painful condition of right arm from an old burn; limb useless	Modified circular amputation, upper third	Recovered	"	For deformity.
125	Dec. 9, 1886	M. Adult. Brakeman	Right arm crushed by railway train	Circular amputation, upper third	"	"	Primary.
126	Dec. 18, 1886	M. Adult.	Right arm crushed by railway train	Modified circular amputation, upper third	"	"	"
127	Feb. 1, 1887	M. 20. Train-hand	Right arm crushed between railway cars	do.	"	"	"
128	Jan. 16 1888	M. 12.	Crush of left arm	do.	"	"	"

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.—*Continued.*

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			IV.—*Amputations through the Upper Arm.*—Continued.				
129	Feb. 24, 1888	M. 15.	Compound dislocation of right elbow and crush of forearm by railway injury	Circular amputation, middle third	Recovered	University	Primary.
130	Feb. 29, 1888	F. Elderly	Gangrene of left arm from embolism following reduction of dislocated shoulder	Modified circular amputation, upper third	"	Pennsylvania	Secondary.
131	April 28, 1888	M. 81. Laborer	Sloughing of right arm from erysipelas following injury	do.	"	University	"
132	June 8, 1888	M. Adult.	Sloughing and suppuration after fracture of left radius and ulna with rupture of brachial artery	Elliptical amputation, lower third	"	Pennsylvania	"
133	April 27, 1889	M. 42. Railway conductor	Crush of right arm by railway injury	Modified circular amputation, upper third	Died	University	Primary. Death in 8 hours from heart-clot.
134	Feb. 8, 1890	M. Middle-aged	Cysto-sarcoma of right elbow	Circular amputation, middle third	Recovered	"	For disease.
135	April 9, 1892	F. 45.	Sarcoma of right humerus	Modified circular amputation, upper third	"	"	"
136	May 31, 1893	M. 12.	Incurable encircling ulcer following lacerated wound of right forearm; muscles destroyed.	Circular amputation, lower third	"	Pennsylvania	Secondary.
137	March 21, 1894	M. Young.....	Crush of right arm	Circular amputation, middle third	"	"	Primary.
			V.—*Amputations at the Shoulder.*				
138	Jan. 10, 1883	M. 30. Brakeman	Left arm crushed by railway train; vessels injured	Larrey's method	Recovered	University	Primary.
139	March 14, 1883	M. 16.	Necrosis of right humerus	do.	"	"	For disease.
140	May 13, 1886	M. 10.	Left arm crushed by railway train	do.	"	"	Primary.
141	Feb. 4, 1888	M. 15.	Right arm rushed by machinery	do.	"	Pennsylvania	"
142	Feb. 20, 1888	M. 25. Brakeman	Left arm crushed by railway train	do.	"	"	"
143	Jan. 6, 1894	M. 12.	Peripheral sarcoma of left humerus	do. (Wyeth's pins)	"	University	For disease.

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.—*Continued.*

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			VI.—*Amputations at the Ankle.*				
144	Feb. 18, 1882	F. Young.....	Chronic disease of right ankle from hereditary syphilis	Syme's method	Recovered	University	For disease
145	March 31, 1890	M. Adult.	Crush of left foot by railway injury	do.	"	Pennsylvania	Primary.
146	Nov. 5, 1890	M. 7.	Caries of left tarsus; os calcis previously excised	do.	"	Children's	For disease.
			VII.—*Amputations through the Leg.*				
147	Oct. 15, 1881	M. 40. Laborer	Caries of left foot following old injury with extensive sloughing and erysipelas	Modification of Lee's method, upper third	Recovered	University	For disease.
148	Oct. 22, 1881	M. 35.	Re-ulceration after compound fracture of leg with great shortening; limb useless	Modified circular method, upper third	"	"	"
149	Nov. 17, 1881	M. 25. Bridge-builder	Right leg crushed by blow from heavy stone	External flap method, upper third	"	"	Primary.
150	Jan. 20, 1882	M. 42. Train-hand	Right leg and foot crushed by railway car	do.	Died	"	Primary. Death from gangrene on 5th day.
151	Feb. 17, 1882	M. 19. Train-hand	Left leg crushed by railway car. Injury of pelvis followed by hæmaturia, etc.	Circular method, middle third	"	"	Primary. Death on 5th day from pelvic injury.
152	May 24, 1882	M. 30.	Crush of left foot and ankle by railway injury; limb severed	External flap method, upper third	Recovered	"	Primary.
153	Oct. 5, 1882	M. 16.	Left foot crushed by railway car	Modified circular method, lower third	"	"	"
154	Oct. 9, 1882	M. 45.	Secondary hemorrhage and sloughing after amputation at left ankle one week previously	do.	Died	"	Intermediate. Death after 2 days from recurrent hemorrhage.
155	Nov. 11, 1882	M. 45.	Painful and ulcerated stump after amputation of left leg two years previously	External flap method, upper third	Recovered	"	Reamputation.
156	Nov. 27, 1882	M. 52.	Right leg crushed by railway car	Antero-posterior flap method, upper third	Died	"	Primary. Death on 6th day from delirium tremens.
157	Oct. 29, 1883	M. 25. Train-hand	Right leg nearly severed by falling telegraph wire by which was caught while riding on top of car	External flap method, upper third	Recovered	"	Primary.

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.—*Continued.*

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			VII.—*Amputations through the Leg.*—Continued.				
158	Feb. 23, 1884	M. 30.	Painful and ulcerated stump after amputation of left leg ten years previously	External flap method, upper third	Recovered	University	Reamputation.
159	March 22, 1884	M. 51.	Warty ulcer of left leg following gunshot wound received twenty years previously	do.	Died	"	For disease. Death on 6th day from gangrene.
160	Feb. 16, 1885	M. 19.	Gangrene following cuneiform osteotomy for inveterate club-foot	Modified circular method, lower third	"	"	Intermediate. Death on 7th day from septicæmia.
161	May 23, 1885	M. 10.	Caries of left ankle	Internal flap method, lower third	Recovered	"	For disease.
162	April 17, 1886	M. Adult. Engine-driver	Deformity of left foot from burn	External flap method, lower third	"	"	For deformity.
163	Dec. 4, 1886	M. 25.	Ulcerated stump after previous amputation of left leg	Modified external flap method, upper third	"	"	Reamputation.
164	Jan. 1, 1887	M. Adult.	Left leg crushed by railway train	do.	"	"	Primary.
165	May 13, 1887	M. 62.	Left foot crushed by railway injury	Modified circular method, lower third	"	Pennsylvania	"
166	June 9, 1887	M. Adult. Laborer	Right leg crushed by railway train	External flap method, up upper third	"	University	"
167	Sept. 24, 1887	M. Adult.	Caries of right tarsus; astragalus previously excised	Modified external flap method, middle third	"	"	For disease.
168	Oct. 29, 1887	M. 57. "Engine-boss"	Crush of left foot and ankle by railway train; fracture of ribs	do.	Died	"	Primary. Death on 11th day from uræmia; granular kidneys.
169	Dec. 3, 1887	M. Adult.	Right leg crushed by railway train. Refused amputation till twelfth day	do.	Recovered	"	Secondary.
170	March 3, 1888	M. 25.	Ulcerated stump after previous amputation of right leg	do.	"	"	Reamputation.
171	June 13, 1888	M. Adult.	Conical stump after previous amputation of left leg	do.	"	Pennsylvania	"
172	July 14, 1888	M. Adult.	Ulcerated stump after previous amputation of left leg	do.	"	University	"
173	July 19, 1888	F. 60.	Compound fracture of right leg by falling downstairs	do.	"	Pennsylvania	Primary.

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.—*Continued.*

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			VII.—*Amputations through the Leg.*—Continued.				
174	Jan. 26, 1889	M. 20.	Ulcerated and conical stump after previous amputation of right leg	Modified external flap method, middle third	Recovered	University	Reamputation.
175	Jan. 26, 1889	M. 26.	Ulcerated and conical stump after previous amputation of left leg	do.	"	"	"
176	March 23, 1889	M. 14.	Sarcoma of left tibia	do., upper third	"	"	For disease.
177	June, 1889	M. Adult.	Ulcerated stump after previous amputation of right leg	do., middle third	"	Pennsylvania	Reamputation.
178	July 23, 1889	M. 20.	Crush of right leg by fall of iron casting	do., upper third	Died	"	Primary. Death on 3d day from prostration.
179	March 29, 1890	M. Young adult	Caries of left ankle	do., lower third	Recovered	University	For disease.
180	July 28, 1890	M. Adult.	Caries of right ankle, recurring after excision	do., middle third	"	"	"
181	July 30, 1890	F. Adult.	Caries of right ankle, recurring after excision	do.	"	"	"
182	Oct. 11, 1890	M. Adult.	Compound fracture of right leg. Refused amputation at first	do.	"	"	Secondary.
183	Jan. 17, 1891	M. 25.	Ulcerated stump after previous amputation of left leg	do., upper third	"	"	Reamputation.
184	Jan. 31, 1891	M. 30.	Compound fracture of right leg by mining explosion; vessels injured	do.	Died	Pennsylvania	Intermediate. Death from sloughing and secondary hemorrhage.
185	Nov. 14, 1891	M. 10.	Right foot crushed by railway train	do., middle third	Recovered	Children's	Primary.
186	Feb. 9, 1893	M. 18.	Left leg crushed by railway train	do.	"	University	"
187	March 18, 1893	M. Young adult	Conical stump after amputation of right leg in childhood	do.	"	"	Reamputation.
188	June 19, 1893	M. 50.	Suppurating arthritis of right ankle	do., lower third	"	Pennsylvania	For disease.
189	March 3, 1894	M. 53.	Dry (embolic) gangrene of right foot and ankle	do., upper third	"	University	"
190	June 15, 1894	M. Adult.	Old injury of left foot; ulceration and anchylosis	do.	"	Pennsylvania	"
			VIII.—*Amputations at the Knee and Knee-joint.*				
191	Nov. 12, 1881	M. Adult.	Compound fracture of right leg from fall, followed by diffuse suppuration and necrosis	Amputation by long anterior and short posterior flap at knee-joint	Died	University	Secondary. Death on 9th day from heart-clot.

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.—*Continued.*

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			VIII.—*Amputations at the Knee and Knee-joint.*—Continued.				
192	Jan. 27, 1883	M. Adult.	Syphilitic necrosis and ulceration of left leg, of more than twelve years' duration	Amputation by long anterior and short posterior flap at knee-joint	Died	University	For disease. Death on 7th day from cardiac thrombosis and embolism of pulmonary
193	Oct. 20, 1883	M. 45.	Warty ulcer following gunshot wound of left leg twenty years before	Antero-posterior flap method, through condyles of femur	Recovered	"	For disease. [artery.
194	Feb. 28, 1885	F. 60.	Recurrent sarcoma of right leg	Anterior and posterior flaps at knee-joint	Died	"	For disease; consecutive hemorrhage. Death from heart-clot and exhaustion.
195	March, 1885	M. Child	Necrosis of left tibia	do.	Recovered	"	For disease.
196	July 17, 1885	M. 44.	Compound comminuted fracture of left leg and lacerated wound of thigh	Antero-posterior flap method, through condyles	Died	"	Primary. Death on 6th day from traumatic gangrene.
197	Dec. 12, 1885	M. 64.	Incurable ulcer of right leg	do.	"	"	For disease. Death on 2d day from heart-
198	Oct. 20, 1886	M. 56.	Crush of right leg	do.	Recovered	"	Primary. [clot.
199	July 29, 1887	M. Adult.	Gunshot wound of left leg followed by gangrene (incipient)	do.	"	Pennsylvania	Intermediate.
200	July 29, 1887	M. Adult. Train-hand	Crush of right leg by railway injury	Anterior and posterior flaps at knee-joint	"	University	Primary.
201	Oct. 16, 1887	M. Adult. Hod-carrier	Crush of right leg by railway injury; lacerated wounds	Antero-posterior flap method, through condyles	"	"	"
202	Jan. 12, 1888	M. 34. Merchant	Crush of right leg by railway injury	do.	Died	"	Primary; delirium tremens, and secondary hemorrhage. Death on 36th day from septicæmia.
203	June 25, 1888	M. 4.	Crush of right leg by railway injury followed by gangrene	do.	Recovered	Pennsylvania	Intermediate.
204	May 31, 1890	M. 25.	Gunshot fracture of right leg, vessels divided	do.	Died	"	Primary. Death on 2d day from heart-clot.
205	May 30, 1891	M. 50.	Warty ulcer following gunshot wound of left leg twenty-six years before	Anterior and posterior flaps at knee-joint	Recovered	University	For disease.

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.—*Continued.*

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			VIII.—*Amputations at the Knee and Knee-joint.*—Continued.				
206	March 22, 1892	M. 54. Wool-merchant	Gangrene of right foot from embolism of popliteal artery (heart disease)	Antero-posterior flap method, through condyles	Died	....	For disease. Death on 7th day from cerebral embolism and hemiplegia.
207	May 19, 1893	M. Adult.	Crush of right leg by freight-elevator; injury of vessels, followed by gangrene	Amputation through dead tissues, at knee-joint	"	Pennsylvania	Secondary. Death from secondary shock same day.
			IX.—*Amputations through the Thigh.*				
208	March 17, 1882	M. 52.	Osteo-sarcoma of left knee	Antero-posterior flap method, lower third	Recovered	University	For disease.
209	June 10, 1882	M. 45.	Secondary hemorrhage following necrosis of left femur with fracture of involucrum	do., middle third	Died	"	Secondary. Death in a few hours from heart-clot.
210	Dec. 9, 1882	M. 30.	Gangrene following injury of left leg received several weeks before; septic when admitted	do., lower third	"	"	Secondary. Death in 10 days from septicæmia present before operation.
211	Jan. 19, 1883	M. 30. Telegrapher	Crush of right leg by railway injury	do.	Recovered	"	Primary.
212	May 23, 1883	M. 30.	Crush of right leg by railway injury	Modified circular method, middle third	Died	"	Primary. Death in 6 hours from shock.
213	Oct. 14, 1884	M. 10.	Compound separation of lower epiphysis of right femur	do., upper third	Recovered	"	Primary.
214	April 4, 1885	M. Adult.	Suppurative arthritis of right knee-joint; hectic; bed-sore	Antero-posterior flap method, lower third	"	"	For disease.
215	April 28, 1885	M. Adult.	Suppurative arthritis of left knee-joint; necrosis of clavicle	do.	Died	"	For disease. Death in 7 weeks from tuberculosis.
216	Aug. 14, 1885	M. 40.	Osteo-sarcoma of right femur	do., middle third	Recovered	"	For disease.
217	Nov. 14, 1885	M. 9.	Flaps sloughed after amputation at right knee-joint for railway injury	do.	"	"	Secondary. Reamputation.
218	June 16, 1886	M. 5.	Suppurative arthritis of right knee-joint, 16 months; strumous	do., lower third	"	"	For disease.

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.—*Continued.*

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			IX.—*Amputations through the Thigh.*—Continued.				
219	Oct. 27, 1886	M. 3.	Disorganization of right knee-joint from hereditary syphilis; disease of skull	Antero-posterior flap method, lower third	Died	Children's	For disease. Death in 2 weeks from brain disease.
220	Dec. 10, 1886	M. 46. Salesman	Compound fracture and avulsion of left thigh by railway injury	Modified circular method, upper third	"	University	Primary. Death in 30 hours from gangrene of stump.
221	May 14, 1887	M. Adult.	Sarcoma of left femur	Antero-posterior flap method, middle third	"	Pennsylvania	For disease. Death in 16 days from gastric ulcer.
222	May 14, 1887	M. Adult.	Diffuse femoro-popliteal aneurism, right side, following gunshot wound 5 months before	do.	Recovered	University	For disease.
223	Nov. 9, 1887	M. 8.	Destructive arthritis of left knee-joint and Pott's disease of spine	do., lower third	"	Children's	"
224	Jan. 5, 1888	M. 11.	Crush and avulsion of left leg by railway injury	do., middle third	"	University	Primary.
225	March 1, 1888	M. 20.	Crush of left thigh by railway injury	Modified circular method, upper third	Died	"	Primary. Died same day.
226	April 19, 1888	M. 8.	Crush of right leg by railway injury	Antero-posterior flap method, middle third	Recovered	Pennsylvania	Primary.
227	May 7, 1888	M. 6. Mule driver	Compound separation of lower epiphysis of left femur by kick of mule	do., lower third	Died	"	Primary. Death in 5 hours.
228	June 10, 1888	M. Adult.	Traumatic gangrene following crush of left leg	Modified circular method, upper third	"	"	Intermediate. Death in 3 hours.
229	Dec. 15, 1888	F. 25.	Sarcoma of right tibia	do., lower third	Recovered	University	For disease.
230	March 16, 1889	M. 56.	Suppurative arthritis of left knee-joint from injury; bed-sores; septic when admitted	Antero-posterior flap method, lower third	Died	"	For disease. Death in 1 month from septicæmia present before operation; stump
231	May 11, 1889	M. Adult.	Warty ulcer following crush of left knee, 17 years before	Oval method, middle third	Recovered	"	For disease. [healed.
232	June 8, 1889	M. 50.	Recurrent sarcoma of right knee-joint	Antero-posterior flap method, lower third	"	"	"
233	Sept. 21, 1889	M. 49.	Crush of right leg by railway injury. Fracture of left leg	do.	Died	"	Primary. Death in 7 hours.

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.—*Continued.*

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			IX.—*Amputations through the Thigh.*—Continued.				
234	Feb. 3, 1890	M. 60. Farmer	Crush of left leg by railway injury	Antero-posterior flap method, lower third	Recovered	Pennsylvania	Primary.
235	Feb. 10, 1890	M. Adult. Laborer	Compound fracture of right knee-joint by dynamite explosion	Modified circular method, middle third	"	"	"
236	April 23, 1890	M. 17.	Suppurative arthritis of left knee-joint; hectic	Antero-posterior flap method, lower third	"	"	For disease.
237	May 21, 1890	M. 55.	Suppurative gelatinous arthritis of left knee-joint; hectic	do.	"	"	"
238	July 23, 1890	M. 50.	Osteo-sarcoma of right femur	Modified circular method, middle third	"	"	"
239	Oct. 18, 1890	M. 52. Miner.	Gangrene following simple fractures of right thigh and leg from railway injury	Antero-posterior flap method, lower third	"	University	Intermediate.
240	March 16, 1891	M. Adult. Milkman	Compound fracture of right thigh by railway injury	Modified circular method, upper third	Died	Pennsylvania	Secondary. Death in 7 hours.
241	March 28, 1891	M. 63. Laborer	Multiple sarcoma of right leg	do., middle third	Recovered	University	For disease.
242	May 18, 1891	M. 30.	Suppurative osteo-myelitis of right femur	Antero-posterior flap method, upper third	"	Pennsylvania	"
243	Feb. 6, 1892	M. Adult.	Conical and painful stump after previous amputation of right thigh	Modified circular method, middle third	"	University	For deformity. Re-amputation.
244	June 16, 1892	M. 25. Apothecary	Compound fracture of right thigh by bursting of soda-water fountain	do.	Died	Pennsylvania	Primary. Death on 7th day from secondary hemorrhage.
245	Nov. 19, 1892	F. 40.	Tuberculous osteitis of left femur from fall on knee, 11 weeks	do.	Recovered	University	For disease
246	Dec. 3, 1892	M. 65.	Recurrent multiple sarcoma after amputation of left thigh	Lateral flap method, upper third	Died	"	For disease. Death in 6 weeks from visceral metastasis.
247	May 13, 1893	M. 52.	Recurrent caries after excision of knee	Antero-posterior flap method, lower third	Recovered	"	For disease.
248	Oct. 21, 1893	F. 40.	Sarcoma of left knee-joint	Modified circular method, lower third	"	"	"
249	April 7, 1894	M. Adult.	Painful neuromata of thigh stump	Modified circular method, upper third	"	"	"

TABLE SHOWING RESULTS OF ONE HUNDRED AND FIFTY-THREE CONSECUTIVE CASES OF SINGLE MAJOR AMPUTATION.—*Concluded.*

No.	Date.	Sex, Age, and Occupation.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
			X.—*Amputations at the Hip-joint.*				
250	May 10, 1884	M. 40.	Necrosis following amputation of right thigh	Oval method	Died	University	For disease; reamputation. Death in 2 days from loss of blood during operation.
251	May 8, 1889	M. Adult.	Recurrent sarcoma of stump after amputation of left thigh	Guthrie's method	"	Pennsylvania	For disease; reamputation. Death after 2 days.
252	Aug. 22, 1889	F. 26.	Recurrent sarcoma of stump after amputation of right thigh	Dieffenbach's method	"	University	For disease; reamputation. Death in 12
253	March 28, 1894	F. 17.	Recurrent caries after excision of hip	Oval method (Wyeth's pins)	Recovered	Pennsylvania	For disease. [hours.

TABLE SHOWING THE PARTICULARS OF TEN CASES OF DOUBLE AND TWO OF TRIPLE SYNCHRONOUS AMPUTATION.[1]

No.	Date.	Sex and Age.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
1	Oct. 27, 1881	Male, 21	Crush of right arm and compound dislocation of right ankle by railway injury. Profuse purulent discharge from ear. Pyæmic symptoms after 2 weeks	Amputation of right arm, upper third, by oval method; amputation of right leg, lower third, by modified circular method	Died in 18 days	University	Primary. Autopsy showed suppuration of internal ear and abscess of lung. Stumps healthy.
2	July 6, 1882	Male, 25	Crush of left thigh and leg and of right foot by railway injury	Amputation of left thigh, upper third, by modified circular method; Chopart amputation of right foot	Died in 23 hours	"	Primary.
3	Nov. 4, 1882	Male, 48	Crush of right forearm and of left foot and ankle by railway injury	Circular amputation of right forearm; amputation of left leg, middle third, by external flap method	Recovered	"	"

[1] A third (successful) case of *triple* amputation has lately been treated in my wards at the University Hospital, by Dr. H. R. Wharton,

TABLE SHOWING THE PARTICULARS OF TEN CASES OF DOUBLE AND TWO OF TRIPLE SYNCHRONOUS AMPUTATION.—*Concluded.*

No.	Date.	Sex and Age.	Nature of Case.	Nature of Operation.	Result.	Hospital.	Remarks.
4	Nov. 7, 1882	Male, 25	Crush of left arm and of left foot by railway injury	Circular amputation of left arm, upper third; modified circular amputation of left leg, lower third	Recovered	University	Primary.
5	Dec. 8, 1882	Male, 40	Crush of right forearm and left foot by railway injury	Circular amputation of right forearm; modified circular amputation of left leg, lower third	"	"	"
6	May 4, 1883	Male, 19	Crush of both feet by railway injury	Modified circular amputation of both legs, lower third	"	"	"
7	Feb. 26, 1885	Male, 35	Crush of right elbow and right leg by railway injury	Circular amputation of right arm, middle third; amputation of right leg, upper third, by external flap method	Died in 12 hours	"	"
8	March 27, 1888	Male, 30	Crush of both wrists by premature explosion of blast	Circular amputation of both forearms	Recovered	Pennsylvania	"
9	Nov. 17, 1888	Male, 30	Crush of both legs by railway injury	Amputation of right knee through condyles by antero-posterior flap method; amputation of left thigh, upper third, by modified circular method	"	University	"
10	May 30, 1892	Male, 45	Crush of both legs by injury from elevator	Amputation of both thighs, lower third, by antero-posterior flap method	"	Pennsylvania	"
1	Feb. 14, 1883	Male, 45	Crush of both feet and of right hand by railway injury. Alcoholic habits	Circular amputation of right forearm and modified circular amputation of both legs, lower third	Died in 10 days	University	Primary. Death from alcoholism. (Triple amputation.)
2	Nov. 28, 1887	Male, 20	Crush of right leg and right hand; avulsion of left leg; compound fracture of skull; by railway injury	Amputation of right thigh, lower third, by antero-posterior flap method; amputation of left leg, middle third, by external flap method; oval amputation of right forearm	Recovered	"	Primary. (Triple amputation.)

My recent cases show a moderate but positive improvement since I have adopted the antiseptic method, my mortality under this mode of treatment having been just 20 per cent. as compared with a death-rate of 29.3 per cent. previously. This gain of less than ten per cent. of the whole number will no doubt seem absurdly small to those enthusiastic operators who are in the habit of declaring that the statistics and experience of pre-antiseptic days are of no value to the modern surgeon, but it is the best that I can offer; indeed, as I have said elsewhere, the advantages derived from antiseptic surgery seem to me to lie not so much in lessened mortality as in a shortened period of convalescence, diminished violence of traumatic fever and infrequency of secondary fever, increased comfort on the part of the patient, and material relief from anxiety and sparing of labor on the part of the surgeon.

SPECIAL AMPUTATIONS.

AMPUTATION AT THE SHOULDER.—While the hemorrhage during this operation can usually be safely controlled by pressure on the subclavian artery with a wrapped key, as directed in Vol. I., page 650, and by having an assistant grasp the axillary artery before it is divided, yet these measures sometimes fail, when profuse bleeding may occur. The conformation of the clavicle is occasionally such as to cause the subclavian to be so deeply placed that it cannot be satisfactorily compressed over the first rib, and unless the vessel is precisely located in the wound and very firmly held, pressure here may fail also; hence in several cases I have with advantage resorted to preliminary ligation of the axillary, making a superficial transverse incision connecting the lateral branches of the oval of Larrey's amputation, and then passing a ligature around the vessel with an aneurismal needle and tying it high up, taking care, in completing the operation after disarticulation, to divide the axillary tissues below the point at which the artery is secured. Another plan, which is perhaps still more satisfactory, is that recommended by Professor Wyeth, of New York, which consists in passing two strong steel mattress-needles or skewers, one on either side of the neck of the scapula, entering one in front and the other behind the acromion and bringing them out at the roots of the axillary folds, and then applying an Esmarch's tube tightly above them. By this plan the circulation is completely controlled, and the patient need not lose a drop of arterial blood until the limb has been separated; the principal vessels are secured before the constricting band is removed, and the smaller ones are afterward rapidly caught with hæmostatic forceps. I have adopted this procedure myself in one case with entire satisfaction, and have also seen it successfully employed by Professor Brinton.

AMPUTATION ABOVE THE SHOULDER.—The most important suggestion in regard to this grave operation which has been made, since the publication of the Article on Amputations in Vol. I., is that of Berger, who strongly advises the preliminary division between double ligatures of both subclavian artery and vein, access to these vessels being facilitated by a resection of the clavicle. The arm and scapula are then

separated from before backward. The statistics of this operation have been considerably increased, and to the fifty-one cases tabulated in Vol. I., page 654, may be added 39 additional cases, as follows:—

ADDITIONAL CASES OF AMPUTATION ABOVE THE SHOULDER.

No.	Operator.	Result.	No.	Operator.	Result.	No.	Operator.	Result.
52	Andradas	Cured	66	Lewis	Cured	79	Parkes	Died
53	Bell	"	67	Lucas-Champion-nière	"	80	Schmidt	Cured
54	Berenger-Féraud	"				81	Senn	"
55	Berger	"	68	McLeod	Died	82	Soudermayer	"
56	Brown	"	69	Id.	"	83	Southam	"
57	Chavasse	"	70	Id.	Cured	84	Thiersch	Died
58	Czerny	"	71	Macnamara	Died	85	Van Iterson	Cured
59	Desprès	"	72	Maling	Cured	86	Verneuil	"
60	Dubreuil	"	73	Martin	Died	87	Watson	"
61	Heath	"	74	May	Cured	88	Weinlechner	"
62	Humphry	?	75	Id.	"	89	Wyeth	"
63	Hutchinson	?	76	Morisani	Died	90	Id.	"
64	Jeannel	Died	77	Ollier	Cured			
65	Keen	Cured	78	Parise	Died			

Of the whole 90 cases, 66 are known to have terminated in recovery and 22 in death, giving a mortality rate in determined cases of only 24.4 per cent. Additional instances of accidental avulsion of the arm and scapula have been recorded by George, Loumeau, Ogilvie, and Stennett, giving, with those referred to in Vol. I., page 654, a total of 18, of which at least 17 are said to have ended favorably.

AMPUTATION OF THE LEG.—Further experience has led me to revise the opinion expressed in Vol. I., page 666, in favor of the circular method in amputating in the lower third of the leg, and I now give the preference to the external flap method at all points between the knee and the ankle. I have found, however, that it is often difficult to shape the flap properly by transfixion in the way which Sédillot recommended, and I have therefore modified his procedure by cutting the flap from without inward, beginning with an incision of three or four inches along the inner edge of the tibia, then crossing the outer side of the leg transversely, and finally cutting upward on the posterior surface, in a line diametrically opposite to that of the wound first made; the flap thus marked out is raised, keeping close to the fibula, and an inner, shorter flap is then formed in the same way; the bones are sawn through at the highest point exposed by the reflection of the flaps—the fibula somewhat higher than the tibia—and the operation is completed in the ordinary manner. The great advantage of the external flap method is that it enables the sawn end of the tibia to be thoroughly covered, and that, the flaps being light and brought together laterally, there is little or no risk of the tibial spine causing ulceration and protruding, as it so commonly does after amputation by other methods. The resulting cicatrix is drawn well away from the line of pressure, and the stump is firm and well-formed, so that the patient can, if necessary, bear a considerable amount of weight on the end of the stump itself.

AMPUTATION AT THE HIP-JOINT.—At the time that the Article on Amputations in the first volume of this work was published, the best mode known to the profession for controlling hemorrhage during hip-joint amputation was the use of the aortic compressor, the disadvantages of which were, however, fully recognized. Since that period many plans have been devised for accomplishing the purpose, old suggestions have been modified and variously combined, and in the hands of surgeons of the present day compression of the aorta has been almost entirely replaced by what is known as the "bloodless method," introduced by Professor Wyeth, of New York, which consists in the application very high up of an Esmarch's tube, kept in position by steel mattress-needles or skewers made to transfix the thigh on either side of the articulation.

As first practised by its introducer, this mode of controlling the bleeding necessitated an operation *à deux temps*, the limb being first amputated in the continuity of the thigh, and the upper end of the femur subsequently disarticulated after ligation of the vessels, and this double operation was necessarily so prolonged that the patient sometimes perished from that cause alone; but by placing the transfixing skewers at a higher point, it is now found possible to complete the disarticulation before removing the constricting tube or band, and thus a source of grave danger is avoided.

It is interesting to trace the development of this method, the adoption of which seems to me to be the greatest improvement in hip-joint amputation which has been effected during the last decade.

Nearly thirty years ago, I was present when the late Dr. Addinell Hewson amputated at the hip, an effort being made to prevent bleeding by the use of a strong acupressure pin passed below the femoral vessels, according to Simpson's first method, and reinforced by pressure of the thumbs of an assistant, who held an end of the pin in either hand and compressed the artery directly upon it; at the most critical moment the pin broke, and though the operator skilfully caught the vessel in the flap, so much blood was lost that the patient never rallied. About fifteen years later, in 1880, Newman and Trendelenburg advocated the employment of a steel rod made to transfix the limb below the vessels, which were then compressed upon it by a bar, or by an elastic cord passed in figure-of-eight turns around its ends; the flap was then cut, the vessels tied, disarticulation effected, and the tissues on the back of the limb finally compressed and dealt with in the same manner.

Furneaux Jordan's method, about which much misunderstanding prevails among surgical writers, consisted in beginning the operation as for an excision of the head of the femur; after disarticulation, the shaft was dissected out through a longitudinal incision on the outer side of the limb, and finally the soft tissues were constricted by means of an elastic band and then cut through at a lower point. Professor Senn has modified and improved this procedure by perforating the tissues on the inner side of the thigh after enucleating the upper portion of the femur, introducing a double elastic tube, tying one part over the anterior tissues, crossing the other posteriorly, and finally bringing it around the whole limb and securing it in front, thus doubly constricting the great vessels. The limb is then removed by cutting a long anterior and a short posterior flap. Various combinations of

Jordan's incision with the use of Trendelenburg's clamp have been employed by Ogilvie Will (who attributes the first use of the skewer to Spence), by Professor Dandridge, and by other surgeons.

The operation known as Dieffenbach's appears to have been first practised by Dr. Brashear, of Kentucky, in 1806. It consists in amputating the thigh by the circular method, hemorrhage being controlled by an ordinary tourniquet, and then, after ligating the vessels, in enucleating the upper portion of the bone through an external longitudinal incision.

It is manifest that neither this operation nor Jordan's, while they would no doubt answer well in a traumatic case, or in one of necrosis or of hip-disease, would be applicable to a case of malignant tumor in the upper part of the femur, where it would be necessary to cut flaps from without inward, and to keep the knife well above the limits of the morbid growth; and it is in this respect that Professor Wyeth's method seems to me superior to all others which have been suggested, in that it allows constriction of all the vessels at the level of the hip-joint itself, permits the surgeon to shape his flaps as he may prefer, and enables him to disarticulate before the constricting band is removed. As originally practised, Dr. Wyeth's method was a modification of Brashear's and Dieffenbach's, substituting the skewers and elastic band for the ordinary tourniquet, and, like that, having the disadvantages of an operation *à deux temps;* but this objection being eliminated, Wyeth's "bloodless method" seems to me to merit all the encomiums which have been bestowed upon it. Its use has certainly much reduced the mortality of hip-joint amputations, 42 cases in which it has been employed having given, according to its author's figures, 33 recoveries and only 9 deaths, a mortality rate of only 21.4 per cent., which, even allowing a considerable discount for unsuccessful cases which may not have been reported, makes a much better showing for the operation than has been obtained in other ways. In my own hands it has been perfectly satisfactory, as it was also in a case at the Pennsylvania Hospital in the hands of my friend and colleague, Dr. R. H. Harte.

TUMORS.

BY

B. FARQUHAR CURTIS, M.D.

PROFESSOR OF SURGERY IN THE NEW YORK POST-GRADUATE SCHOOL, SURGEON TO ST. LUKE'S HOSPITAL AND TO THE NEW YORK HOSPITAL.

THIS article is intended to be supplementary to that of Mr. Butlin, in Vol. I., bringing down to date the subjects with which he has dealt, giving an account of those topics which have been introduced or made the subject of more special study since that time, and particularly placing in the reader's hands a clue for further personal investigation in all directions, by references to more recent monographs.

The order of arrangement, however, will be different from that adopted by Mr. Butlin, in that after dealing with the etiology and other general subjects, the teratomata will be first considered, including with them the branchiogenic cysts, dermoids, and odontomata; secondly, the neoplasms of the connective-tissue group will be studied; and, using the endotheliomata as a transition form, I shall pass, thirdly, to the epithelial tumors.

CLASSIFICATION.

An elaborate differentiation and classification of the varieties of carcinoma and other tumors may appear like an unnecessary refinement, but a study of the variations in the clinical history of growths commonly classified together, variations which I shall have to dwell upon hereafter, shows the necessity for seeking more delicate histological distinctions between these tumors than are usually made. Without this more exact differentiation, microscopic study of the structure of neoplasms will not prove as useful clinically as it should be. It is well then to bear in mind the wise words used by Virchow in defending the histological basis of our knowledge of tumors, of which a translation would read as follows:—

"The diagnosis depends upon the knowledge of the histological character of the growth, and not so much upon the identification of the genus as upon the precise verification of the species. Pathological tumors in this respect resemble plants. It is not enough to ascertain that a plant belongs to the family of Solanaceæ, nor even that it is of the genus Solanum; its poisonous nature can only be determined when we have discovered which species of Solanum is before us. It is exactly the same with the carcinomata and sarcomata."

In fact, the importance of the classification of tumors as a preliminary to their proper study cannot be gainsaid, and naturally the continual discovery of new facts requires repeated alterations in the old systems. The most complete of the recent attempts in this line is that of Monod and Arthaud. They adopt Cohnheim's theory of the origin of neoplasms from misplaced and surviving particles of embryonic tissue. Monod claims that he has proved in a study of giant-cell sarcoma, undertaken with Malassez, that tumors of that form are of endothelial origin, and, when the intimate connection between all sarcomata and the blood-vessels is taken into account, the authors think their endothelial origin may be taken for granted. It should be noted, however, that this view has by no means received general acceptance. Their classification is based on the number of layers of the blastoderm concerned in the production of the different varieties, and therefore three great divisions are formed: I. Teratomes, from all three layers—dermoid cysts, for instance. II. Mixed tumors, from one or two layers, including (1) *Ento-mesodermic* or *ecto-mesodermic*, the mixed epitheliomata (chondromatous, myxomatous, myomatous, sarcomatous, and lipomatous); and (2) *Mesodermic*, the mixed "endotheliomata" (chondro-sarcoma, myxo-sarcoma, myo-sarcoma, and lipomatous sarcoma). III. Pure tumors from a single layer, subdivided into (1) *Ectodermic:* (*a*) Epithelial type, embracing adenoma and papilloma, typical epithelioma, and metatypical epithelioma. (Among the typical epitheliomata are included the pavement, lobulated, "pearl"-bearing, papillary, tubular, glandular, and cornified forms; the metatypical group comprises the encephaloid, scirrhous, hematode, and reticulated carcinomata.) (*b*) Adult or differentiated type—neuroma, both myelinic and amyelinic. (2) *Entodermic*, altogether epithelial, and subdivided just as the last class into adenoma, and typical and metatypical epithelioma. (The adenomata include those of the intestine, etc.; the typical epitheliomata embrace cylindrical epithelioma of the intestine, stomach, liver, kidney, testicle and ovary, and the mucoid form; the metatypical epitheliomata include the carcinomata of the same organs. Finally, (3) *Mesodermic*, subdivided into, 1, the endothelial, and 2, the adult or differentiated type. Of the endothelial are (*a*) angeioma and papilloma (plexiform angeioma and lymphangeioma, papilloma of serous membranes); (*b*) typical endothelioma (angeio-lithic sarcoma, giant-cell sarcoma, lymphangeiosarcoma, lymphadenoma, cylindroma, endothelioma, endothelial sarcoma, melanotic sarcoma of eye); and (*c*) metatypical endothelioma (lympho-sarcoma, diffuse melanotic sarcoma, myxo-sarcoma, and glioma). Of the adult or differentiated type are the connective-tissue growths (chondroma, lipoma, myxoma, and fibroma) and muscular-tissue growths (rhabdomyoma, leiomyoma).

This classification includes only the true tumors, and the authors exclude rigorously all inflammatory or trophic overgrowths, whether connective-tissue or epithelial, such as rheumatic nodules, laminated fibromata, keloids, neuromata of amputation, lipomata due to a "diathesis," bony plaques in serous membranes, exostoses, ecchondromata, "fibromyomata" of the uterus, warts, retention cysts, goitres, leucæmic lymphomata, etc. This classification is very complete, and even to those who object to the authors' derivation of all sarcomatous tumors from the endothelium, there is great interest in following the analogies be-

tween the epithelial and sarcomatous or endothelial tumors which they have worked out on this plan.

In distinguishing between benign and malignant growths, W. Rogers Williams lays stress upon the influence of the independent cell-life in the production of tumors, and claims that the distinction is essential and inherent in the differences between the life of the cells in lowly and highly organized tissues. In tissues of low organization, the main feature of the cell is growth and reproduction; in the highly organized it is functional, fulfilling some duty for the rest of the organism. In the former it is free from restraint, while in the latter it has lost its autonomy, perfected its evolution, diminished its vitality, and is under the restraining influence of the organized tissue of which it is a part.

Consequently, in such growths as lipoma and adenoma, the cells come nearer to having a distinct function, and are less dangerous, than in sarcoma and carcinoma, where they are elementary, growing wildly without restraint, their whole vitality occupied in unlimited and objectless reproduction.

Frequency of Occurrence.

The fullest clinical statistics as to the occurrence of neoplasms yet collected are those of Williams, based on 14,480 cases of tumors of all kinds in certain of the great London hospitals, and those of Gurlt, based on 16,637 cases from similar sources in Vienna. These reports include both medical and surgical cases, and are at least representative of the clinical side of tumors as they appear in the class of population which is liable to be found in general hospitals. As there may be reasons in race or climate, or in some local condition, which cause the discrepancies between these two sets of figures, and as each has a sufficiently large number of cases to rule out any questions as to accidental variations, such as might affect the results of smaller collections, I shall give these sets of figures separately, where they seem useful in considering the various forms of growth, rather than attempt to combine both in order to obtain averages.

In the first place, some idea as to the relative frequency of the various forms of tumor may be obtained from the following table:—

Table Showing Relative Frequency of Various Forms of Tumor.

Neoplasm.	Williams.	Gurlt.		
		Male.	Female.	Total.
Lipoma	561	127	191	318
Fibroma	1661	51	647	698
Chondroma	81	73	63	136
Osteoma	261	14	9	23
Myxoma	29	3	1	4
Lymphoma	....	....	....	357
Neuroma	....	12	13	25
Angeioma	157	79	115	194
Sarcoma	1350	398	483	894
Carcinoma	7878	....	....	....
Papilloma	286	40	53	102
Adenoma	505	....	....	44
Cysts	1640	276	1048	1325
Thyroid tumors	....	125	155	280

Summing up their results in percentages, the malignant epithelial growths form, according to Williams, 55 per cent.; according to Gurlt, 67 per cent. of all tumors, while sarcoma forms only 9.4 per cent. according to Williams, and 5.4 per cent. according to Gurlt. Among the benign tumors, the solid growths form 25 per cent. (Williams), or 19 per cent. (Gurlt) of all neoplasms, and the cysts comprise 11 per cent. (Williams) and 8 per cent. (Gurlt).

Etiology.

It should be borne in mind that the general term "tumor," even under all the limitations of modern pathology, includes many very different pathological entities, some being fœtal errors of structure almost belonging in the class of monsters, while others resemble closely the locally infectious diseases.

The study of tumors in the lower animals and in vegetables gives us some vague hints in the direction of etiology. Animals have most of the neoplasms that are found in man, but they have others which are undoubtedly parasitic in origin. In the vegetable kingdom we find most tumors originating from erratic bud development (Williams), a condition exactly parallel to that assumed to exist in Cohnheim's theory of misplaced fœtal fragments, and a large class which are due to parasites, or, more properly speaking, to the injection of irritating fluids around the eggs of parasitic insects.

Cohnheim's theory has gained almost universal acceptance, the various objections to it having been largely overcome, and although it is probably incapable of direct proof, still some recent discoveries in the structures of cells afford a partial demonstration. Some would include in tumors the infective granulomata, such as tuberculous masses and syphilitic gummata, but it appears more wise to exclude such simple inflammatory masses with a definite and well-known causation. Excluding these then, we have on the one hand the dermoid cysts, which are unquestioned instances of fœtal inclusion, closely allied to the monsters, and on the other hand the malignant tumors, of uncertain origin but least likely to be due to dormant germs of fœtal tissues, while between these two classes lie the benign tumors, which seem as if they might be due to some germ particles of fœtal tissues, and yet are not clearly fœtal inclusions. The etiology of these different groups is probably as different as their pathological and clinical features, and between the various types are many steps and gradations.

Cohnheim founded his hypothesis on the analogy of the dermoid cysts, assuming that similar deposits of fœtal tissues, very minute, perhaps consisting of only one or two cells, might exist in many places in the body where they would lie dormant, preserving their fœtal characteristics undeveloped until some irritation should cause them to grow, and that by thus growing out of place with the full reproductive power of fœtal cells they would produce tumors. Roux, while making some experiments in which he destroyed one-half of the frog's embryo at a very early period, found that the destroyed portion was sometimes reproduced or revivified by the remaining cells, and in these portions he frequently discovered cells which belonged to the earliest

embryonic period, scattered through all the layers, evidently survivals of that time of regeneration and unusually active reproduction. Struck with the resemblance between the occurrence of these isolated persistent early cells and what he fancied must be the condition hypothetically described by Cohnheim, he examined many specimens of normal frog-embryos, with the result of finding in one of them, in which the medullary canal had already closed, eight such persistent cells distributed among the three fœtal layers. But even if this theory is well grounded, it does not properly explain all the facts in regard to neoplasms, especially the occurrence of many cases in which epithelial malignant growths have been observed to start directly from normal epithelium with no sign of misplaced tissue.

The only other of the older theories which enter into competition with Cohnheim's, are those of Klebs, and of Thiersch and Waldeyer, who attempted to account for epithelial and malignant growths. Virchow, at the time of publishing "Die krankhaften Geschwülste," had supposed that epithelial cells might develop from any indifferent cells, originating even in the connective-tissue structures, and ascribed the origin of carcinoma to these cells. Klebs admitted that the carcinoma must in the first place originate in the epithelium, but imagined that this abnormal growth was due to a union with the epithelium of wandering leucocytes which were taken up into, or impregnated, the epithelial cells, comparing the process to the fecundation of the ovum by the semen in ordinary generation. But before Klebs made this attempt to combine Virchow's old theory with the new dictum of biology, that like begets like, and that epithelium cannot originate from connective-tissue cells, Thiersch and Waldeyer, entirely abandoning the old notions and accepting the newer ideas, had sought to explain the origin of epithelial growths by a loss of the physiological balance between the epithelial layers and their connective-tissue basement membrane. Thiersch had observed that, in the aged, the epithelial structures of the lip preponderated over the connective tissue, as compared with their proportions earlier in life, owing to an atrophy of the connective tissue. It is generally admitted as a physiological fact that there is a sort of pressure exerted on the parts beneath by the epithelial layers of the body, and as long as this is evenly distributed and evenly met by the resistance of the basement connective tissue, a balance is preserved between the two, and they maintain their normal structure and relations. But if this balance should be disturbed, either by unusual activity of epithelial growth or by atrophy of the connective tissue, the epithelial cells would insinuate themselves into the interstices of the latter, and then grow in branching processes like widespreading roots. The unknown cause of all this abnormal activity is probably identical with the ultimate cause of malignant growths, which we are still seeking. We know that traumatism, either momentary or in the shape of long-continued irritation, will sometimes cause this epithelial overgrowth, but in many cases traumatism and irritation are entirely absent, so that we are led to conclude that it can only be a predisposing rather than an efficient cause.

Schuchardt and Karg have recently dwelt upon the difficulty of obtaining opportunities to study epithelial growths early enough in their development to ascertain the actual beginning of the process. Schu-

chardt figures a section through a very small epithelioma of the lip, which shows that in one respect our previous ideas have been incorrect; for the most marked characteristic of the specimen is an increase of the thickness of all the layers of the skin—squamous cells, rete Malpighi, and corium—with hypertrophy of the papillæ. Not only is there a very marked increase in the thickness of the cornified epithelial layer, but there are areas of cornified epithelium scattered through the layers of softer cells near the papillæ. The latter fact is in line with the recorded observations of Schuchardt and others, in which the *eleidin* (Ranvier's cornifying substance) increased in the epithelia of the skin under irritation, an increase which appeared to be a constant accompaniment of epitheliomatous change as well as of various slight changes such as psoriasis and leucoplakia, both of which have been shown to lead to epithelioma.

Karg gives us an observation, founded on a case of Paget's disease of the nipple, in which he found, in portions of the new growth where the tissues were otherwise healthy, and where the epithelium as yet showed no tendency to invade the connective tissue, many isolated epithelial cells which were greatly enlarged, and the protoplasm of which was clearer and more transparent than normal, the enlarged nuclei at the same time being darker. These altered cells he thinks were the bodies which Wickham and Darier took for psorosperms, and he considers this the beginning of the carcinomatous change, the starting-point therefore being in the individual epithelial cells.

These somewhat contradictory observations illustrate again how little we really know of the ordinary microscopic appearances of malignant tumors.

Parasitic Origin of Malignant Growths.—The feeling that malignant tumors are due to some parasitic growth is apparently gaining ground. From their origin in one place (primary malignant growths being so rarely multiple), their systematic spread to the surrounding tissues and along the lymphatic vessels, their metastasis to distant organs, their tendency to break down, and their appearance in otherwise healthy individuals, the theory of their origin in a parasitic infection has become very enticing. The resemblance between them and tuberculosis and syphilis in particular is very close. But careful and continual search after the usual vegetable parasites, such as bacteria, has resulted in nothing, Hall, Scheuerlen, and many others proving false prophets. As has been justly pointed out, if there be a parasitic cause in the malignant growth, its action must be totally different from that with which we are familiar in the case of bacteria, for the latter only cause "inflammation" and the production of granulation tissue, whereas the parasite which is to cause a neoplasm must have the power of making both connective-tissue cells and epithelial cells increase and multiply, and also give them the power of lymphatic infection. The facts so far proven appear to be these: First, certain animal parasites, the coccidia, inhabit the epithelial cells and have the power of affecting their growth in certain of the lower animals; secondly, there have been observed in the epithelial cells of carcinoma certain "bodies" or "inclusions" which somewhat resemble the coccidia, occurring in a certain parasitic disease of the lower animals. The rabbit and the sheep appear

to be most liable to coccidiosis, which affects the biliary ducts of the liver in the former, and the intestinal glands in the latter. This parasite appears to cause a multiplication of the epithelial cells, and indeed of the mucous membrane in its entire thickness, so that a section of the tissues at the seat of infection closely resembles in its histological structure an adenoma of the rectum in man. Sections of the bile ducts show an unequal proliferation of the walls, forming papillary outgrowths which fill the lumen of the canals very much as the intracanalicular growths project into the ducts in fibroma of the mamma. These coccidial parasites are swallowed by the animal while in a quiescent state, and then develop and multiply in the host, being situated within the epithelial cells and swelling them to a large size. They form spores which are thrown out and undergo a preliminary development outside of the body, secreting strong capsules, and are able to exist for a long time in this intermediate quiescent state while awaiting a new host. The appearance of the parasites in the liver and gall-duct epithelium of the rabbit has been found to very closely resemble certain bodies or formations observed recently in the cells of cancer. The general interest in these discoveries began with the description of "psorosperms" in Paget's disease by Wickham and Darier, although Thoma, Sjöbring, Albarran, Malassez, and others had already noted peculiar bodies in cancer cells. Then Russell in England followed with observations on certain bodies to be seen by staining with fuchsin, including in his descriptions many forms which were cell-generations, but also undoubtedly some which were the true parasite. Ruffer, Walker and Plimmer, and Soudakewitch and Metchnikoff followed. Many excellent authorities deny the existence of the parasite, and the proof is still incomplete, but it would seem that the general belief in the new theory is constantly gaining in strength. For the history and literature of this subject, already so extensive, we must refer to Ruffer and Walker,[1] and to Councilman.[2]

The most definite descriptions and logical demonstrations of these "inclusions" or "parasites" are those given by Ruffer and Walker, and by Plimmer. They describe the main forms. One, which they consider to be the very young parasite, appears in the nucleus of a cell as a small round body, staining well with various dyes, and is evidently a foreign body absolutely independent of the nucleus itself. The second form, supposed to be the more developed parasite, contains a minute nucleus and a distinct capsule. Transition figures are seen which are supposed to indicate that the parasite bursts from the cell-nucleus into the protoplasm of the cell, where it develops to its full size and may push the cell nucleus aside and cause its atrophy. There may be several of these bodies in one cell. Finally, a third, supposed adult form, which consists essentially: "(1) Of a central, round, oval, or slightly irregular nucleus, sometimes connected by fine delicate rays with the periphery; (2) of a variable amount of surrounding protoplasm, almost if not quite filling up the capsule; and (3) of the double-contoured capsule surrounding the whole."

The supposed parasites vary from 0.004 mm. to 0.04 mm. in size. The nucleus of the "parasite" does not stain easily with ordinary

[1] Journal of Pathology and Bacteriology, vol. i., p. 198, and vol. ii., p. 3.
[2] Medical News.

nuclear dyes and hematoxylin; in fact, its reactions correspond to those observed by Pfeiffer in the coccidia of the rabbit. Moreover, with some dyes it assumes a different color from the cell nuclei in the same sections, for instance, turning blue with the Ehrlich-Biondi mixture which stained the nucleus and nucleolus of the epithelial cell red. Several other differential staining tests have been discovered, such as hematoxylin and cochineal, in which the nucleolus of the epithelial cell stains blue, while the parasitic nucleus takes up the cochineal. Various appearances have been observed which are supposed to represent multiplication by division and the formation of spores.

It appears certain that these bodies, whatever their true nature may be, are not the mere vacuoles formed in the protoplasm of cells, especially under the influence of irritation, which have been recently so well studied in both epithelium and cartilage by Power, for it would be impossible to explain their complicated staining peculiarities under that supposition. Ruffer does not admit the observations of Arnold, from which the latter deduced the theory of a method of formation of new cells inside the parent cell following the fragmentation of the nucleus described by him, and this adverse opinion of endogenous cell-formation appears to be quite generally held by pathologists. Ruffer thinks that this appearance of endogenous formation can be best explained by the common features of cell invagination. The last-named peculiarity of cells, by which one cell projects more or less into the body of another neighboring cell, Ruffer considers will not only produce the appearance of endogenous formation, but will also produce the forms called parasites by Délépine, Wickham, Darier, Albarran, Hutchinson, and Bowlby. But from his own cell-inclusions or "parasites" these are readily distinguished by the fact that they have dark nuclei which are easily stained by the nuclear dyes, which, as we have seen, do not readily stain the nuclei of the bodies described by Ruffer. Even when these invaginations have undergone degeneration, they show remains of chromatin and coarse protoplasm which are characteristic. It is true that they sometimes appear to have a capsule, owing to a double-contoured boundary which forms between them and the cell into which they are invaginated, but this should not mislead. These cell-invaginations are common in the skin, and apparently they can be produced at will by oblique sections of the epithelium of the cornea. Finally, the bodies described cannot be due to the complicated chemicals used in preparing the specimens, because they are to be found in perfectly fresh, unprepared specimens. It would seem therefore that Ruffer and his fellow-workers have considered and eliminated all obvious sources of error, and it must be admitted that they have at least demonstrated a peculiar body in cancer cells, which resembles microscopically the coccidia.

It is true that no cultures or inoculation experiments have yet been made, but it must be remembered that as yet we know of no method by which to cultivate any of the coccidia outside of the body. As to inoculation experiments, the question of the contagiousness of cancer is often confused with that of its supposed parasitic origin; but they are distinct issues, and it must not be forgotten that even if it should be impossible to adduce any instances of direct contagion, the disease might still be infectious and caused by a parasite. I shall have occa-

sion to refer hereafter to certain cases which have been considered by some to be instances of direct contagion, but, as we shall see, they are all explicable as examples of the grafting of cells and tissues, and are therefore of no value in deciding the present question. It must be remembered, too, that the coccidia, like many other animal parasites, have a stage in which they exist outside of their host, and therefore the first victim does not communicate the disease directly to the next. It may indeed be necessary for the parasite to pass through an intermediate host like many other organisms of this kind. Such objections as these, therefore, do not settle the question of the parasitic origin of cancer adversely. It is to be hoped, however, that in the future some inoculation experiments may succeed, for without them there could scarcely be any absolute proof that the newly discovered body, or any other body proven to be a parasite, which was demonstrated in malignant tumors, was really the cause of their growth, for it might be only an accidental accompaniment of the neoplasms.

But there are other more serious objections. In the first place it must be remembered that the complicated modern methods of histological study which have brought to our knowledge these new objects, have not yet been sufficiently employed in the examination of normal epithelium, and before deciding upon the nature of these recently discovered bodies in the abnormal cells of neoplasms, we should ascertain all the peculiarities of the normal cell when examined in the same thorough manner.

A very strong objection to the attempt to construct a parallel between carcinoma and coccidiosis, as it appears in the lower animals, is the fact that the latter disease lacks completely the peculiar mode of general infection by secondary deposits by way of the lymphatics and blood-vessels, which is so invariable and characteristic a feature of malignant tumors. The suggestion of some that this could be explained by the supposition that carcinoma was produced by a different variety of coccidium, is, to say the least, an unsatisfactory answer.

When we reflect that the secondary tumors of malignant growths, no matter where situated—whether in lymphatics, in glands of totally different structure, or in the bones themselves—preserve the histological arrangement of the gland in which the primary tumor appeared, it is still more difficult to comprehend how any parasite could exert such a complicated and far-reaching influence. To accomplish this result we must assume that the parasite has the power of causing a vigorous growth of epithelial cells, not only making them multiply in their original situation, but causing them to grow in any new locality whither they may be transported by lymphatic or blood-currents, and that it also has the power of making this growth in both situations reproduce the normal structure of the gland from which the cells originated. One might grant that a parasite, being carried with the cell to its new habitat, could cause the cell to increase and multiply there, and one might assume that a cell from the mucous membrane of the stomach, finding itself in the liver, would still multiply in such a way as to represent the epithelial parts of the gland from which it came; but what influence causes the growth of connective tissue around the new epithelial cells, so as to reproduce the stroma and connective-tissue envelopes just as they existed in the stomach glands?

It is perhaps not an impossible hypothesis, but at least it demands great extension of our theories of the powers inherent in epithelial cells, to suppose that these cells have individually the property of influencing the connective tissue around them so that it will assume just the shape to which they are accustomed, and we shall certainly do well to ask for some further facts before we accept it even as a hypothesis. That the power of thus modifying the connective tissue as well as the epithelium should reside in the parasite, is quite beyond the bonds of credibility. If we can assume for the cell such wonderful coercive power, it does not appear to me that the recent discovery (Waring) that the cells of carcinomatous growths, both primary and secondary, retain the function of the gland from which they originate, adds anything to the difficulty of the supposition; for if cells from a carcinoma of the stomach can produce in the liver the structure of a stomach-gland, it surely is not very surprising that they should produce there the same secretion.

One final objection requires notice. If we accept the parasitic theory as proven, how can we explain the fact, which must follow as a corollary, that a parasite, residing for instance in a carcinomatous cell of the stomach, when carried into the liver should not cause the surrounding liver cells to take on carcinomatous growth and produce a typical hepatic carcinoma? In the present state of our knowledge it is impossible to answer any of these objections, and we must rest satisfied for the time with the facts already demonstrated, thankful at least for the renewed interest which has been awakened in this difficult problem.

Whether this new doctrine is accepted or not, the discussion has brought out some old views in new lights which are worth noting. Thus Sims Woodhead, following Thiersch's example in the study of epithelioma of the lip, has examined and recorded the senile changes in the tongue. He finds that with the advance of age the connective tissue becomes atrophied, but the epithelial layer retains the thickness characteristic of the adult (in the infant there is only a very delicate epithelial layer) and finger-like processes are seen passing down into the connective-tissue spaces, sometimes with small cell-nests of thickened epithelium, so that the normal structure closely resembles epithelioma. If no irritation occurs, the epithelium finally joins in the general atrophy, but at the stage just described it is easy to see that a slight degree of irritation might readily cause abnormal growth and true epithelioma.

GEOGRAPHICAL DISTRIBUTION.—The geographical distribution of malignant tumors has been studied by various investigators, but more especially by Haviland, in Great Britain, and by some recent French writers. Haviland, limiting himself to cancer occurring in women, found that the disease was most prevalent in low-lying, damp regions, and the French authors support him in this conclusion, which is very interesting in view of the fact that coccidiosis is most common in rabbits running on wet lands, since it has been sought to connect the diseases etiologically. Haviland's conclusions, however, and the mortuary statistics upon which they are founded, are questioned by Hirsch; and Owen, in the collective investigation of this question made by the British Medical Association, could find no evidence of their truth, so that

we need still further study of the subject before it can be accepted as settled in either way.

CONTAGION.—The French writers (see Guelliot) have considered this subject more from the point of view of contagion than from that of climate, and the facts observed allow of explanation in either way. Thus, while in Paris the number of deaths from cancer is only 104 per 100,000 inhabitants, five times less than the number of deaths from tuberculosis—and the same holds true of other cities, the number in Lyons, the worst, being 163—in many French villages this proportion is much increased. Arnaudet, Lucas-Championnière, Desplous, and Manichon report from four villages a proportion of deaths from cancer equal to 345, 200, 266, and even 1400 per 100,000 inhabitants. The common climatic bond between these hot-beds of the disease is marshy ground, as I have already noted. Arnaudet, however, thinks that the cause must lie in the drinking-water, especially that used to make cider, the favorite beverage of the region, but he also lays stress upon the fact that the disease seems to cling to certain dwellings, appearing in successive occupants often not connected by blood relationship. Thus, in the course of thirty years, thirty-one cases of cancer occurred in one group of seventeen houses out of fifty-four. As he justly remarks, such causes of malignant tumors as infection of the water supply, or of dwellings, could easily be overlooked, as they might be concealed under the appearance of heredity. In addition to these cases, Wheeler reports from Castine, a town in Maine (U. S.), that fourteen cases occurred within a radius of two or three blocks.

In many instances mentioned by the authors just quoted, successive occupants of one house, or individuals not connected by any blood-relationship, have been attacked by the disease, so that the conclusion is almost irresistible that some strong contagious factor is present, whether this contagion be due to the drinking-water, as Arnaudet suggests, or whether it be transmitted directly or indirectly from one individual to another. Many cases of supposed direct personal contagion of cancer are to be found in surgical literature,[1] but there are few instances which have been scientifically observed, with microscopic examination of the tumors, and the majority are mere coincidences. Among these instances of contagion or coincidence we may note that quoted by Clement Lucas, of a man with rodent ulcer of the eyelid and forehead, whose wife was seized with scirrhus of the breast, and whose partner, who lived in the same house with them, was finally afflicted with epithelioma of the tongue. Whitehead gives the instance of a middle-aged man who died of epithelioma of the lip which he attributed to drinking from the same vessel as his father, who had died of the same malady a year before his own disease showed itself. Guelliot saw a man, his wife, his servant, and his father-in-law, all die of cancer (of the rectum in the men, of the breast in the women), all of them leading very confined lives in one apartment, and all of the deaths occurring within five years. Arnaudet saw two bitches occupying in succession the same kennel, affected within two years with cancer of the vulva. Isolated cases of epithelioma of the penis in the husband have been observed to follow uterine epithelioma in the wife, but those re-

[1] Williams, Lancet, 1891, vol. ii., p. 607.

corded by Bruce and Demarquay appear to be the only authentic instances, and with the great frequency of uterine carcinoma it is strange that infection does not occur more often if there is any real danger of its taking place. Budd instances the case of a terrier which, accustomed to lick the face of its master who had cancer of the lip, acquired and succumbed to cancer of the tongue before the man died. It is easy to see how cases of contagion occurring, as they would be very likely to do, in one family, would furnish evidence apparently in favor of heredity.

But is there not some more definite evidence of contagion or infection by direct contact? Many attempts have been made to transplant tumors in animals, and a few in man, but such attempts have almost invariably met with failure. Von Eiselsberg succeeded in transplanting fibro-sarcoma from rat to rat, Hànau accomplished the same for carcinoma, and Wehr transplanted carcinoma in dogs. Even in these cases it is not certain that the tumors would have continued to grow, for the usual result of such operations has been the shrinking and the final disappearance of the mass, although at first it may show some signs of increase. Hahn, in a patient who was suffering from disseminated carcinoma, transplanted three small nodules to a healthy part, when the transplanted tissue healed in and attacked the healthy skin around it, enlarging at the expense of the latter. Von Bergmann says that he has repeated this experiment successfully. Cornil reports two similar instances from the practice of a surgeon who, with excellent reason after such a criminal proceeding, kept his name secret. In one case, while operating for the removal of a sarcomatous breast, he transplanted a portion of it to the healthy breast of the other side, and after the graft had taken and begun to grow, excised it, the microscopical examination showing the development of a tumor exactly like the parent growth. In another case, the same proceeding was carried out upon a patient suffering from carcinoma, who, however, refused to submit to the second operation, so that no microscopical examination was possible; but there was sufficient clinical evidence that a new tumor had formed. Nicaise saw a sarcoma develop in the abdominal wall at the site of puncture of a sarcomatous uterus, made with a trocar under supposition that it was a cyst; and Schopf has reported recently a case in which two lateral incisions in the healthy tissues of the vulva, made during a vaginal hysterectomy for cancer, became infected with the disease.

With these instances of implantation, we can class the numerous cases in which an ulcerating epithelioma has caused an infection of some other part of the body kept in close contact with it. Such instances have been noted by Lücke, in the tongue and cheek; by von Bergmann, in the upper from the lower lip; by Hamburger, from one labium minus to the other; by Cripps, on the breast and the adjacent arm; by De Morgan, on the breast and the underlying skin of the side; and by Kaufmann, in the eyelid infected from an ulcer on the back of the hand used to rub it. Similar to these are the cases of pavement epithelioma of the stomach secondary to a primary epithelioma of the mouth, œsophagus, etc., primary epithelioma of the stomach being unknown; and also the instances of multiple peritoneal carcinoma following a subperitoneal growth of one of the viscera, likened by Virchow to

scattered seeds growing on a hillside, originating from a plant at the top. Perhaps we should class here, too, those curious cases in which carcinoma develops in a laparotomy scar after the removal of an apparently benign ovarian cyst, just as ovarian cysts sometimes recur as malignant affections in the stump or adjacent organs, although at first innocent as far as our means of diagnosis enable us to determine. Although all these cases indicate a certain contagious element in cancer, they do not imply anything more than the continuance of cell life as illustrated in any graft of normal tissues; for even if the cancer cells should adhere and grow, and invade healthy tissue in a new locality, it is after all just what they are doing at their original seat of growth, and there is no proof that they influence the tissues in the one place more than in the other. In other words, it is no proof of infection by germs of any sort, by chemical products, or even by the exceedingly vague and hazy "spermatic" influence so much talked of at one time. Yet the facts are worth collating, for not only do they contain the possibility of assisting in the final discovery of the etiology of these mysterious pathological processes, but they also have some very practical bearings, in emphasizing the necessity of avoiding all chances of fresh inoculation of the wounds made during operations for the removal of malignant growths.

CONNECTION WITH SYPHILIS.—Von Esmarch has advanced a theory which is as impossible of contradiction as it is of proof, that the sarcomata are late developments of syphilis, appearing in the second or third generation after the syphilitic infection has apparently died out. He founds this hypothesis on the frequency of syphilis, its long continued influence in a family, and the close anatomical resemblance between gumma and sarcoma. One strong argument, however, against it is the frequent occurrence of sarcoma in persons whose family history is perfectly free from any syphilitic taint, as shown by persistent good health. If the disease does not show its ordinary symptoms in the ancestors, it is not easy to understand how it could retain enough strength to develop an affection so markedly malignant as sarcoma, in a later generation. Latent and tardy syphilis is common enough, but the occurrence of such irregularities as these is extremely improbable.

TRAUMATISM.—In considering the effect of traumatism in the causation of tumors, we must distinguish three different kinds of action.

(1.) The purely mechanical dislocation of a portion of tissue which may grow independently in a new situation, and there form a tumor. This has been pretty clearly demonstrated in the case of those epithelial tumors of the fingers and hands, usually cystic and resembling dermoid or sebaceous cysts, but occurring in regions where sebaceous glands do not exist and where dermoid cysts are rare. From dermoids they are also distinguishable by a lack of the papillary layer of the cutaneous lining (although this is not invariably present in dermoids), and especially by the fact that they do not usually occur in the interdigital folds, where, from the infolding of the epidermis during development, the formation of a dermoid cyst might be expected. Many cases are now on record (Poland, Barker, Reverdin), in which the history of traumatism is clear and convincing. Christiani has reported the occurrence of

a similar but solid epithelial growth on the skin of the forehead. These cases recall the experiments of Hunter, Kaufmann, Masse, Schweninger, and others who artificially produced epithelial cysts resembling sebaceous cysts by transplanting or simply turning in fragments of skin in the subcutaneous tissues.

(2.) The development of a tumor directly after an injury, usually a blow, and without surface lesion. The injury is usually a contusion, and presumably the formation of a hæmatoma may be of etiological importance to the growth of the tumor. Although it is generally malignant and especially sarcomatous tumors which follow these injuries, benign tumors have also been observed under such circum stances. *Lipoma* after a contusion has been recorded by Bellamy, in a man struck on the forearm by a cricket-ball; by Courtade, on the knee; by Leclerc, on the back of the neck; by Reboul, over the trochanter of the femur, and by Laurent, on the side and front of the chest. Van Arsdale has recorded a case in which an irregular *ossification* took place in the brachialis muscle, and perhaps also subperiosteally on the humerus, in consequence of repeated blows upon the arm; and although in this case we have to do with the ossification of a hæmatoma, or with an ossifying myositis, not a true tumor, the occurrence is worth noting in this connection. Midway between the benign and malignant should be enrolled Madelung's case, reported by Grisson, of an *enchondroma* which sprang from the head of the humerus in a seaman directly after a severe injury, was removed with the head of the bone, and after another similar injury, three years later, reappeared, necessitating the removal of the entire extremity in order to extirpate the growth. On both occasions intense pain in the shoulder was felt at once on receipt of the injury, and this continued, although it was some months before any swelling was noticed. The slow growth, freedom from metastasis, and microscopic examination all declared against any sarcomatous element in these tumors.

The bones seem to be the parts most likely to develop *sarcoma* after injury, and large numbers of such cases are on record; in fact, some such history is obtainable from the majority of cases of sarcoma of bones. In the soft parts these cases are not so common. Blanc, however, reports an instance in a man forty years of age, who received a blow upon the forearm, but continued to work until increasing pain attracted his attention to the part some days subsequently, when he found a hard, tender swelling of considerable dimensions. This was treated by a physician for some time without improvement, the tumor, however, at first not increasing in size. Finally the growth was extirpated, and proved to be a fleshy mass with a soft centre like a broken-down hæmatoma, but on microscopic examination the solid parts were found to be sarcomatous. The growth returned eighteen months afterwards, and was again extirpated, but when last seen the man had symptoms of metastasis to the lungs. Neuhahn has reported similar instances, and has collected forty-one from various sources, three having been in nævi irritated by scratching or unsuitable surgical treatment, and one having followed a blister. Sarcoma of the breast has also been frequently observed to follow a blow. Lindner reports such a case, which was under his own observation from the first, the tumor appearing during the first few days after the injury, and being natu-

rally taken for an inflammatory mass; amputation was finally performed seven weeks after the injury, but recurrence took place and death followed. Bessel-Hagen instances a case of sarcoma of the jejunum which developed in a boy seven years old soon after a blow upon the abdomen from a man's fist. Gross found a history of trauma in ten per cent. of his cases of sarcoma of the breast. In one case of congenital sarcoma in a child, there was a history of a severe blow upon the abdomen of the mother during the sixth month of pregnancy (Phillips).

Carcinoma and *epithelioma* are not nearly so common after single severe injuries. They have most frequently developed in the mamma. Gross, in his collection of 1511 cases of carcinoma of the breast, found a clear history of injury in over thirteen per cent., and in one quarter of these it was proven that the tumor had originated directly from the induration which followed the injury. Fink in his 190 cases found antecedent trauma in over twenty-one per cent., while in thirteen per cent. the tumor came directly from the residual lump. Some observers, however, find the proportion as low as four per cent. Combining all the available figures with those of Gross, the average becomes twelve per cent. Blum and Duval have recorded a case in which a man eighty years of age abraded the backs of both hands accidentally; one healed naturally, but the wound of the other remained open, ulcerated, and became epitheliomatous. Perhaps this case belongs rather to the next variety of traumatism, and probably we should so classify a case observed by myself in a woman past middle age, who had received a burn upon the back of one finger; the wound never healed, but ulcerated and became epitheliomatous, requiring amputation of the member less than six months after the injury.

(3.) The third variety of traumatism is that due to chronic irritation—from the hot clay-pipe of the workman, the sharp corner of a decayed tooth, the contact of soot or crude paraffin, the friction of a calculus in the urinary bladder (and perhaps also in the gall-bladder), and the slight but constant irritation of such inflammatory conditions as fistulæ, ulcers, leukoplakia, lupus, psoriasis, etc. The not infrequent association of mastitis with cancer, and the development of epithelioma in cicatrices, must be included in this category. As to mastitis, Gross found that in 907 cases of women with carcinoma of the breast who had borne children, in 104 cases, or 13 per cent., there had been mastitis in the diseased breast, while in 49 cases, or over 5 per cent., the tumors could be directly traced from the induration left from that attack. Sarcoma is much rarer than epithelioma as a consequence of chronic irritation, although Seydel has reported a case in the site of an old gunshot fracture which had healed with a sinus. In similar situations, such as old necrosis cavities, epithelioma has been found by Nicoladoni, Feigel, and Krevet.

Schuchardt carefully studied the changes occurring in the epithelium in psoriasis (leukoplakia) buccalis, in chimney-sweep's cancer, and in the epithelioma following seborrhœa of the aged, and found in all an increased growth of cells with greater tendency to cornification, and an increase in the quantity of the chemical substance which is present wherever cornification of the epithelium occurs, named "eleidin" by Ranvier. He also reports a case in which he observed changes of the

skin of the glans penis, similar to leukoplakia and associated with epithelioma. Shield and Butlin have seen leukoplakia of the tongue develop after epithelioma had already appeared.

Malignant disease (usually epithelioma, but sarcoma has also been observed) may develop in scars, especially in those due to burns and suppuration, where the amount of cicatricial tissue is great, and in cicatrices upon which there is considerable traction or pressure. Usually the malignant disease follows upon chronic and obstinate ulceration, but it also develops in unbroken cicatrices in the form of hard nodules. Contrary to the ordinary history of epithelioma, that developing in scars may appear early in life. Such cicatricial epitheliomata have not infrequently been observed in the ulcers of conical amputation stumps.

SEX.—The occurrence of the various forms of neoplasm varies greatly in the different sexes. The most complete statistics upon this point are those of Williams and Gurlt, already quoted, who found that women were twice as liable to neoplasms as men (Gurlt, 30 per cent. males, to 70 per cent. females), chiefly because of the liability of the female reproductive organs to these diseases, 69 per cent. (50 per cent. Gurlt) of neoplasms in women affecting these organs. In 7878 cases of *epithelioma* and *carcinoma*, the proportion of males to females was 1 to 1.7, according to Williams; in 10,425 cases, 1 to 2.5 according to Gurlt; and here the same reason explains the difference, for over 75 per cent. of epithelial growths in women attack the reproductive organs. Gurlt shows that of all patients treated in the hospital, 60 per cent. were males, so that tumors were relatively even more frequent in women than is indicated by these figures. Rodent ulcer, however, showed a proportion of males 1.6 to females 1. There were 108 cases of cancer of the lip in males, but only a single case in a woman, and other cancers affecting the mouth were seven times as frequent in men as in women.

In *sarcoma* the sexes were more nearly balanced, there being 702 cases in males against 648 in females (Gurlt 398 to 483), only 23 per cent. (33 per cent. Gurlt) of these tumors in women affecting the reproductive organs. In the *benign tumors* and *cysts* the proportions were again male to female as one to 2.9 and 2.6 respectively (1.9 and 3.8, Gurlt), the great disproportion here being due to the large number of fibrous tumors of the breast and uterus, and of cysts of the ovary.

AGE.—Recent studies have only confirmed the statements of the past in regard to age, but it may be well to emphasize the fact that although in general terms it may be said that each variety of tumor has its accepted ordinary age for appearance, there are many exceptions to the rule as laid down in the text-books. It is true that most lipomata and fibromata appear in early adult life, that most angeiomata appear in infancy or are congenital, that exostoses and enchondromata belong to adolescence, and finally that sarcoma usually occurs in very early infancy, or young adult life, while the epithelial malignant growths belong to middle life or later. But these statements must only be taken in a general way. For instance, fibroma of the uterus has been observed as early as 10 years (Tillaux), while sarcoma of the humerus

has been seen at from 75 to 83 years of age (case of Bouisson), with slow growth and no secondary tumors. Carcinoma of the uterus has been found at 8 years (Ganghofner), and even at 2 years of age (Rosenstein), and sarcoma of the same organ at 3 (Smith), while sarcoma of the vagina has been observed several times in infants. Carcinoma of the rectum has been observed at 17 years in 2 cases, and even at 12 (Allingham), and 11 (Stern). Carcinoma of the penis has frequently been observed at less than 25 years, and of the kidney at 21. Thompson has found 7 cases of cancer of the prostate under 10 years of age, Tordens reports one in an infant of 9 months, and Wyss finds that when that organ has been attacked, 35 per cent. (of 24 patients) were under 10 years; but Thompson's 7 cases are included among these 24, and in case of error on his part this statement would be greatly altered. Carcinoma of the testicle has been seen at 18 months (Schlegtendal) and at 6 years of age (Jacubasch). A large epithelioma of the scalp developing in the cicatrix of a burn, and perforating the skull, has been recorded by Braun, and I have seen a case almost identical. Braun's case began at 14 years, mine at about 8. Carcinoma has been observed in the pylorus at 17 (Köster), and even 14 years of age (Scheffer), and in the small intestine at 3½ years (Duncan). Sarcoma of the intestine has been observed at 5 years (Stern), and twice at 7 years of age, and in the urinary bladder sarcoma has been seen at 5 (Chiara), and even at less than 2 years (Dittrich). Israel observed carcinoma of the kidney as early as 21, and in the pancreas it has been found at 13.

It might be hoped that the study of tumors which occur in the fœtus, and are found already present at birth, would have added something to our knowledge of their etiology, but it has not materially done so, although the facts discovered have great interest. First, when the mother has malignant disease it would not be very strange to find it in the new-born infant, but curiously enough children under such circumstances are very rarely affected. Friedreich reports the case of a woman with multiple scirrhous nodules in uterus, liver, mammæ, bone, intestine, etc. (primary in liver), who died soon after the birth of a child which lived only six days, and bore on the skin over one patella a tumor of exactly the same scirrhous structure, but with no metastases. It should be noted that there was no tumor on the inside of the uterus, and none in the placenta. Secondly, it is in accordance with our ideas of certain tumors of undoubted fœtal origin, that they should be present and of sufficiently large size to attract attention at birth. Besides the various dermoid cysts, there are the numerous tumors of the sacral and coccygeal region, many of which are true teratomata, or even monsters either parasitic or included, and also the congenital cysts, and the hairy polypi of the pharynx. Ott collected eight cases of these polypi, and was convinced that they should be classified with the teratomata.

Rather stranger is it when we find the ordinary benign tumors occurring in this way. But *lipoma* is quite common, even excluding the diffuse fatty hypertrophy—fatty overgrowth combined with degeneration affecting all the tissues of a limb, even the bones being increased in size. Congenital lipomata are usually deep-seated, adherent to bones, tendons, and nerves, and encapsulated, though Jacobi denies this; in fact, Plettner found that one-fifth of the one hundred cases

of subfascial lipoma which he was able to collect were of congenital origin. *Fibroma* is rarer, but has been found in polypoid form on the jaw (Piskaçek), in the vagina (Martin), and bladder (Marsh), and not infrequently in the skin, especially of the forehead. *Osteoma* is less common, but cases are on record in the leg and about the superior epiphysis of the humerus (Pott), while *chondroma* is known only in the form of small tumors lying subcutaneously over the sterno-mastoid muscle, probably of branchiogenic origin (Bidder, Treves), although Sutton thinks that they may represent supernumerary auricles—a deformity of which he has seen two or three well-marked examples. *Myoma* of congenital origin has been observed in the heart wall by two or three observers (Recklinghausen). *Angeiomata* of various forms are of course common, occurring in the lymphatics as well as in the blood-vessels.

But most unusual of all is the early occurrence of malignant disease, especially the epithelial forms, in children born of healthy parents. In fact it may be legitimately doubted if *carcinoma* ever thus occurs. The only recorded cases appear to be the following:—Noeggerath reports a child born dead of a healthy mother, in which the liver weighed two pounds and was carcinomatous. Wedl (quoted by Ahlfeld) reports a case involving the liver, pancreas, and mediastinal glands. Widerhofer and Parker give cases affecting the liver. Ahlfeld reports from the body of a siren monster, with imperforate anus, a carcinomatous nodule developed in the mucous membrane of the blind end of the large intestine, but the amount of deformity in this case renders it unsatisfactory. Arnozan says that two cases have been recorded of cancer of the pancreas in the new-born. Cullingworth found in a child who died in five weeks of inanition, due to persistent vomiting beginning ten days after birth, a polypoid tumor which grew from the internal surface of the lower border of the pylorus, and occluded that opening, its structure being described as a "cylinder-celled epithelioma." Finally, Ritter reports a pedunculated tumor removed from the end of the nose of a new-born child, which also had tumors in the parotid and submaxillary regions, probably secondary glandular growths. The latter continued to increase, and caused death by suffocation in three weeks. He calls the tumor a carcinoma, but according to his description its structure resembled rather that of a sarcoma. Epithelial malignant growths are therefore at best very rare in the fœtus and new-born child.

Sarcoma, however, is quite a common form of growth in the new-born. Jacobi collected over 40 cases of sarcoma of the kidney, and 12 others in the head, leg, scapula, jaws, femur, axilla, ovary, and tongue, to which we may add still others in the foot (Rehn), face (Zahn), shoulder (Mandillon), umbilical cord (Kaufmann), intestine, liver (De Ruyter), suprarenals, mesenteric glands, thyroid (Zahn), and cheek. Osteo-sarcoma, which Cristiani declares to be very rare, has nevertheless attacked the lower jaw in three cases, the scapula, and the femur, beside the case of involvement of the tibia reported by Billroth. Holmes gives a case occurring in the skin of the back of the neck in a child 14 days old, with no recurrence in six months after operation.

HEREDITY.—The doctrine of heredity in the etiology of new-growths, which at one time was unquestioned, has of late years been more thor-

oughly and scientifically investigated and has consequently lost adherents. In fact it is a common experience of surgeons to have patients ask the question, "How could I get this tumor? Nothing of the kind was ever known before in our family, and I have always been healthy." Yet there are some curious instances in which the inheritance of various kinds of tumor, or at least the existence of a family predisposition to them, cannot be denied. Thus Smith records two cases of multiple polypi of the rectum occurring in one family. Ranecke reports a case in which a man, his son, and four grandchildren, had multiple exostoses; and Reulos mentions a still more remarkable case in which a man and three sons all had congenital exostoses in the inferior extremities, with others developing subsequently, while the sister of this man, her daughter, four children of the latter, and seven grandchildren, were all afflicted in the same way. About thirty-five such instances are now on record. Blaschko reports a curious case in which all the male members of a family had multiple lipomata, appearing at puberty, while the female members were unaffected. Puls observed a mother and daughter both suffering from cystic fibroma of the breast, one being 56 and the other 23 years of age, and the tumors having appeared within a year of each other. Paget's cases, published in 1857, 1862, and 1866, showed in 500 cases of malignant disease a cancerous relative in 24 per cent., and in 147 cases of benign tumor a cancerous relative in less than 7 per cent., which would indicate that there was some hereditary influence, although slight.

Williams in 121 cases found a family history of cancer in 16 per cent., including all relatives, but his statistics are intended (as were Paget's also) to show the family tendency. If we limit the question to the direct inheritance of cancer, including only parents and grandparents in the search, the proportion becomes very much less. Cripps gives a calculation based on 169 cases, and finds disease present in the parent in 11 cases only, not including two of a doubtful character. The fallacies which may surround a calculation like that of Williams are illustrated in his own figures of the number of times in which he found a phthisical relative in the families of these 121 cases, the proportion amounting to 50 per cent. Would not a general census of the population have given approximately the same figures both as to cancer and phthisis?

The occasional occurrence of malignant disease in sisters or brothers, or in groups of individuals, parents and children, reported by various observers, is certainly too striking to be passed over as a mere coincidence; but cannot these cases be readily explained as a series appearing in one house, or among a group of friends, due to contagion, either personal or derived from some common source? This subject has already been discussed. We know, also, of some racial predispositions to tumors, such as that of the negro to fibromata, which are worth noting in this connection. Some individuals are certainly more prone to the development of neoplasms than are others.

CONNECTION WITH LITHÆMIA, ETC.—Certain facts have been discovered in regard to malignant disease which are worthy of notice in this discussion of its etiology. Some French authors, especially Verneuil, have revived the old idea of an intimate connection between cancer and

gout, or lithæmia in some form. Working somewhat on the same lines, Rommelaere has found that the *urea* excreted is diminished in amount in individuals bearing a malignant neoplasm, and has even insisted that this fact might be utilized in the diagnosis of doubtful cases. Thus Thiriar, in a study of 46 cases of abdominal tumor submitted to operation, found that the urea was normal in amount whenever the tumors were benign, but decidedly diminished, below 12 grammes per diem, when they were malignant, and that, too, independently of effects which could be ascribed to cachexia. Other observers contradict this statement, as for instance Ranzier, who found that the diminution of urea was proportionate to the degree of cachexia which existed, for in 13 patients with benign abdominal tumors only 6 (with complicating nephritis) had the urea diminished, while of 9 malignant cases in all but 2 there was less than the normal quantity, and in one case it was possible by this means to make the diagnosis between ulcer and cancer of the stomach. A recent study by Toepfer of the *nitrogen* excreted in these cases reveals an additional fact of great interest. Working in Professor Frank's laboratory in Vienna, he studied 22 cases (2 normal, 10 with various diseases, 9 with carcinoma, and 1 with sarcoma), finding the urea diminished in all the carcinomatous cases, but also in those of tuberculosis, atheroma with marasmus, and ulcer of the stomach. Curiously enough, it was increased in the case of sarcoma. But he also studied the nitrogen contained in the uric acid, ammonia, and extractives, separately, with the result of finding a remarkable increase of the nitrogen contained in the extractives, amounting to from six to twenty-five times the normal amount, and this difference was limited to the carcinomatous tumors and was completely independent of cachexia, as it was present even in small epitheliomata of the lip and nose.

The *blood* also has been investigated in these diseases. Neubert had found that the corpuscles and hæmoglobin, but especially the latter, were markedly diminished in malignant disease, when, under the guidance of Mikulicz, Bierfreund studied a very large number of cases and declared that benign tumors did not affect the composition of the blood, nor its rate of regeneration after severe losses. Malignant tumors, however, are associated with reduction of the amount of hæmoglobin, before the general health appears to have been affected, and even after removal of the tumor, with freedom from recurrence for two or three years, it is found that the fluid has not regained its normal characteristics. If great loss of blood has occurred, the blood is not regenerated as rapidly as usual, requiring from twenty-three to twenty-seven days instead of the fourteen to twenty days needed in health. I am careful to say that these changes are *associated* with malignant tumors, because it is impossible to determine, in the present state of our knowledge of this obscure subject, whether the changes are the result of the tumors, or are in some way connected with their cause. But the facts have been demonstrated as stated.

It may be as well to note in this branch of our subject the question of the connection between malignant disease and tuberculosis. On the one hand, various authors have stated that tuberculosis excluded malignant disease, so rare was the combination of the two. On the other hand, a few have so frequently found a family history of tuberculosis in ques-

tioning cancerous patients, as to imagine that a tendency to tuberculosis predisposed an individual to cancer also. Lubarsch, in a very thorough study of the subject based on over 6000 post-mortem examinations, found that of 2668 tuberculous individuals 4.4 per cent. were also carcinomatous, while of 3868 not tuberculous, 11.7 per cent. were carcinomatous. Of 569 carcinomatous individuals 20.6 per cent. were also tuberculous, while of 5967 not carcinomatous, 42.7 per cent. were tuberculous. Hence tuberculous individuals are less liable to cancer than others. In the combined cases no organ was specially involved, and in particular not the alimentary canal, though the œsophagus was supposed by Lebert to be especially liable. This immunity is not due to the difference in age at which the diseases prevail, for phthisis is also most common at from fifty to seventy years. It is a fact that carcinomatous individuals are less prone than others to all the infectious non-traumatic diseases, such as typhoid fever, pneumonia, etc.

METAMORPHOSIS.

That benign tumors change their characteristics in occasional cases and become malignant, cannot be denied, but perhaps many supposed instances of this change are really cases where tumors of malignant structure have run a slow course or have remained quiescent for years. But in studying these changes it is necessary to distinguish three possible ways in which the metamorphosis may occur. Thus an ulcer may form on the surface of a benign growth, as in a suppurating sebaceous cyst, or a projecting fibroma of the breast, and an epithelioma or sarcoma may develop upon this surface just as in any other ulcer. Or a benign epithelial tumor such as the cystic disease of the breast described by Reclus, or a simple adenoma, may by irritation or from some unknown cause change the type of its growth, and become malignant. It is possible also that a malignant tumor may develop in the substance of a benign one as well as in any normal tissue. Besides, it is possible that a benign tumor might, by the irritation of its pressure, cause the growth of a malignant neoplasm in the neighboring parts. We do not include here the development of epithelioma on the epithelial surfaces of dermoid cysts, but perhaps we should include those obscure cases in which after the removal of a benign ovarian cyst recurrence takes place, and recurrence of a malignant form.

Among the commonest of these changes is the development of an epithelioma from an ordinary *wart*, either of the congenital or of the acquired form. Volkmann, in his monograph on primary cancer of the extremities, has carefully studied these cases, collecting from literature and from the elder Volkmann's experience a dozen examples of each variety, and has worked out the curious fact that cancer developing in the congenital warts is far more dangerous to life than that from the acquired wart, not a single instance of cure after operation being known in the first class, while in the second the prognosis is excellent. This change seems to be rarer in the mucous membrane than in the skin; at least Simon collected 10,747 cases of papilloma of the larynx, and found only 45 in which the change to a malignant growth occurred.

A recent paper by Dowd collects many cases of such changes, especially those in *fibrous tumors* of the breast, following a paper by Hall which reported many instances in which tumors of malignant structure had been in existence for a long time. One of Hall's cases I knew of personally:—

A young woman of 21 had had a tumor of the neck, with all the characteristics of an ordinary hypertrophied lymphatic gland, for five or six years. This was removed in 1884 because a brother of the patient had recently died of a malignant tumor of the pharynx, and she felt nervous about it. Hall considered the growth to be a myxo-sarcoma. The patient to my knowledge is still alive, without recurrence, ten years after that operation. Hall had another case of this sort, and Dowd also reports one under the care of Hartley.

Five years ago I removed a breast from a woman 39 years of age, who had first noticed a mass the size of a bean four months before, with pain in the breast and arm. The breast was found to contain several sensitive, movable nodules, not adherent to the skin, and with no retraction of the nipple; the most prominent of the nodules was about half an inch in diameter, lying directly under the skin, and feeling like a very tense cyst. Exploratory incision revealed a very dense tissue, almost as hard as scirrhus, surrounding a small cyst, with enlarged glands in the axilla which could not be felt through the skin; besides removing the entire breast, the axilla was cleared. Microscopic examination by Freeborn showed chronic mastitis with simple hypertrophy of the lymphatic glands, but in the vicinity of the cyst described above there was a distinct nucleus of commencing carcinoma. This patient has remained well.

Verneuil reports two cases of mammary neoplasm which were either instances of carcinoma running a chronic course, or of a change from a benign to a malignant growth. In one, a tumor of long duration, supposed to be benign, proved to be carcinomatous when examined. The other was a case of multiple tumors supposed to be cysts; a similar tumor which had been removed three years before had been proven by examination to be an adenoma, but these tumors turned out to be scirrhous.

Reverdin relates a case of tumor of the breast of five years' duration and slow growth, in which ulceration and fungus developed, and examination on removal showed the growth to be a sarcoma. Labbé and Coyne relate the histories of four cases similar to this.

Billroth relates the case of a woman, 40 years old, from whose breast he extirpated a cysto-adeno-sarcoma after three years' growth. A small nodule near the tumor showed beginning carcinoma, and there was an early recurrence of pure carcinoma. Pilliet has reported two cases in which cystic disease of the breast (Reclus) was followed by carcinoma.

Pompiniel relates the history of a woman 50 years of age, who had had a small hard tumor in the breast for twenty-one years. An ovarian epithelioma was removed, and three months afterwards the mammary tumor began to grow and to give pain; when it was removed a year subsequently, it was found to be an epithelioma, and it recurred twice within two years.

Epitheliomata from *ulcerating and suppurating sebaceous cysts* are not uncommon. I have seen one during the last year, and Dowd reports a case. Franke reports one in the ball of the thumb, and Shattuck and Hutchinson have each seen one. Poulsen records a case in which a mammary carcinoma developed from a nævus in a man.

I have already mentioned the instances in which epithelioma has de-

veloped from the skin in *dermoid cysts*, but may add that Biermann has observed one in which a sarcoma developed under the skin in such a tumor. Chambard has seen so-called carcinomatous change in two cases of *molluscum pendulum*, without any preceding ulceration, but according to his description of their minute structure the growths would seem to have been tubular endothelial sarcomata rather than carcinomata.

There has been considerable discussion of the question whether *uterine fibro-myomata* ever become malignant. Cases are on record of the carcinomatous infection of myomata which already existed, especially by epithelioma which spread to them from the overlying mucous membrane, and of recurrent fibroid tumors (probably carcino-sarcoma); and Liebmann reports a unique case of true myo-carcinoma, in which there grew in the uterus a tumor of mixed myomatous and carcinomatous tissue, and in which the metastases had the same structure of muscle cells and epithelial cells combined. A very strong argument against the occurrence of this change, or at least against its frequent occurrence, is the number of women in the negro race who are afflicted with fibroma, while they possess relative immunity from carcinoma; for if the degeneration were frequent, they should be more liable to carcinoma than women of the white races.

Ovarian cysts are prone to a malignant degeneration, but in a form which differs from what is ordinarily understood by cancer. This change is supposed to occur in them in from 14 to 17 per cent. of the cases. Very difficult, in fact impossible of explanation is the frequent development of malignant tumors in the pedicle, or in the abdominal wall, after an ovariotomy for an apparently benign cyst. Many such cases are now on record; cases in which the clinical history and appearances at the time of operation gave no hint of malignancy, and yet in which within a few months malignant tumors developed. These tumors evidently differ from the epitheliomata which occur in cicatrices in any situation, and the only possible theory at present to account for them is the doubtful one that the original tumor at the time of its removal had already begun to undergo malignant degeneration, but that the change was so little advanced as to escape notice.

Bayer has reported a case in which an ordinary *mucous polypus of the nose* was followed by malignant recurrence or change, apparently a unique case.

Both multiple fibroma and multiple sarcoma of the skin are known, but it is rarely that the two are found in common. Westphalen, however, reports a case of multiple *neuro-fibroma* of the skin, in which sarcoma developed from one of the tumors; but he could find only two similar cases on record, although the change is one which we should naturally expect to be common when we recollect how much the larger nerve-tumors resemble sarcoma in their structure.

As an instance of chronic course in a sarcoma, Hall relates the case of a man who for many years had carried a small subcutaneous tumor of the back without change of symptoms. It was extirpated, and proved to be a sarcoma of small round and spindle cells with little intercellular substance. Poulsen reports, among 33 cases of sarcoma of the breast, 10 which had existed for five years or more, and one which had been present for thirty-six years, remaining quiescent until the menopause, when it began to grow rapidly.

These scattered cases show that there is a real danger in allowing benign tumors to grow without attention. They should be removed in patients whose health will enable them to bear an operation, and if they cause pain, or grow rapidly, or ulcerate, they should be treated like malignant growths. Certainly no one would now irritate warts or papillomata, or obstinate ulcers, by the slight caustic applications once so popular. Butlin's advice to excise all chronic ulcers of the tongue is judicious, for when the wounds are closed by sutures they heal rapidly, and there can be no doubt that those ulcers form the starting-point for malignant disease.

The advantage of operating upon benign tumors was strikingly shown in a case of my own:—

A woman of 48 years, with a family history of several members being afflicted with tumors of various kinds, had a small fatty growth on the back of the thigh, which had been there for nine years to her knowledge, and had never given her any trouble except some slight pain, apparently due to its pressure upon the sciatic nerve over the course of which it lay. I removed the tumor, which was partly subfascial, and sent it to the pathologist in the routine way, supposing it to be an ordinary lipoma; and was greatly surprised to receive from him the report that in its centre lay two lymph nodes the size of small peas, which had shown under the microscope typical carcinomatous changes. Unfortunately the patient was lost sight of when discharged, but a thorough general examination while in hospital gave no clue to any primary disease elsewhere, and she appeared to be in perfect health.

TERATOMATA. (DERMOID CYSTS. BRANCHIOGENIC CYSTS. ODONTOMATA.)

Including under the head of teratomata all those tumors which are due to some perversion or error in fœtal development, we must consider with teratoma in the limited sense those congenital cysts which arise from the branchiogenic clefts, from any of the fœtal ducts, or from any remnants of fœtal tissue, and the odontomata as well.

BRANCHIOGENIC CYSTS arise from fragments of the epithelium covering the branchial arches, which should properly disappear with their coalescence. If this coalescence is incomplete, there are left small cavities lined with epithelium, and from the continued growth and secretion of these cells they are distended so as sometimes to form large cysts. Sometimes this failure to unite occurs in such a way as to leave a complete passage through the soft parts from the skin to the mucous membrane of the pharynx, forming a congenital fistula. These fistulæ may be closed at one end, either the internal or the external. Sometimes when closed at one end by inflammation or operation, the deeper parts will form a cyst, which is then really branchiogenic although not congenital. Gussenbauer relates a case of this kind, in which the patient was accustomed to keep open the cutaneous opening of a cervical fistula which was closed internally, by passing into it a small splinter of wood. This piece of wood became lost inside of the fistula one day without the patient's knowledge, and the external opening closed over it. Twenty-four years subsequently Gussenbauer operated for the cyst which had formed by the dilatation of this closed fistula, and found the piece of wood con-

tained in a cavity which had all the anatomical appearances of a congenital cyst.

These branchiogenic cysts may be found anywhere in the lines of union of the branchial arches, and are either multilocular or, more commonly, unilocular. If formed from the epithelium near the cutaneous surface of the arches, they are lined with flat epithelium, containing sebaceous or fatty débris like dermoid cysts, and this is the most common form. If formed from the deeper portions of the cleft they have a cylindrical epithelial lining, which may be ciliated, and their contents are more mucous. The walls both of the cysts and of the fistulæ are remarkable for containing large quantities of lymphoid tissue, the lymphoid cells being scattered without regularity throughout the stroma, or gathered in masses forming follicles. Gussenbauer has even found small lymph glands in their walls, and claims to have repeatedly observed in operations for their extirpation that the lymphatic glands along the great vessels were absent. On this he bases a suggestion that the cysts may originate in the fœtal structures for producing these glands, claiming that he has demonstrated the development of the epithelial cells which line them directly from the lymphoid tissue, and adducing Lücke's case as evidence.

Lücke described many years ago a cyst lined with epithelium, which he claimed had developed from a cervical lymph gland, but this observation, which has caused so much argument among pathologists, was probably a misinterpretation of a very thick-walled branchiogenic cyst, that form of tumor being then unknown, and, as we have seen, its walls containing lymphatic gland tissue in considerable amount.

Branchiogenic fistulæ and cysts also contain small fragments of reticular cartilage in their walls, and occasionally these fragments grow and form chondromata, which are puzzling to account for if this possible source is not borne in mind. Samter has published a very curious case in which a multilocular cyst in the neck of a man was found to consist of a combination of three separate kinds of cyst, the dermoid, mucous, and lymphatic. The last-named variety was due to lymphangeiomatous change in the walls of the original cysts. This growth recurred, and soon after a second operation the patient died, and was found to have extensive metastatic tumors in the lungs and pleura, and behind the peritoneum. The secondary tumors resembled the first, except that there was more of the lymphangeiomatous element, and fewer dermoid cavities. I have considered elsewhere the epitheliomata and carcinomata which may originate in these branchiogenic remains.

Dermoid Cysts.—Dermoid cysts consist of sacs, the inner layers of which are similar to those of normal skin, and in which all the appendages of normal skin are found, including sweat and sebaceous glands, papillæ, hair, teeth, and, in birds, feathers. The cavity of the cyst is filled with fluid or cheesy matter, which represents the secretions and waste productions of the cutaneous surface. Sometimes, however, the skin is reduced to a thin layer of flat epithelium, and no papillæ are to be found. Sometimes the contents of the sac will be a thin transparent oil, and such cysts are usually translucent. In a few cases a clear serum has been found in cysts which contained hair, and were evidently

dermoid in origin, compelling the supposition that the fluid came from the sweat glands; Giraldès reports such a cyst situated over the anterior fontanelle. Occasionally other tissues are found in the sac walls, just without the layer of skin, and nearly every tissue of the body has been found represented here, except striped muscle. Bone and cartilage are common, and even ganglionic nerve tissue as well as peripheral nerves have been found. Still rarer are portions representing the glandular structure of the various mucous glands. When these masses of tissue begin to assume the shape of normal organs or extremities, some authors would call the cysts true teratomata, or monsters by inclusion, but the transition is a very gradual one, and often the resemblance to normal organs is more fancied than real. The most commonly found organ in these tumors is the mammary gland, and this is readily understood, for morphologically the breast is only a modified sebaceous gland. Baumgarten in one very complicated ovarian cyst found a small cavity with a pigmented lining resembling the choroid, which he interpreted as being an eye, but without the retina, although there was abundant central nerve matter near by. The same cyst had parts representing the mucous membrane and glands of the stomach and intestine, and many other tissues. The ovarian dermoids are the most complicated in structure, the "sequestration" cysts usually representing only the normal skin of the part from which they are derived; Sutton says that he knows of no case in which teeth have occurred in cysts of this variety, of course not including among them the odontomata. Lannelongue, however, has reported a dermoid cyst of the cheek which contained teeth. It should be noted that cysts which contain hair among their contents may have none growing upon their walls, just as the scalp may become bald with advancing years.

The theory of Remak that dermoids were invariably due to infoldings of the ectoderm during fœtal development, has been successfully applied to an extent of which its author probably never dreamed, and even in the case of dermoids occurring in such organs as the brain, it has proved capable of application. I shall follow Sutton in his classification of dermoids into *sequestration dermoids*, *tubular dermoids*, and *ovarian dermoids*, although I do not think it expedient to consider together, as he does, the dermoids and the solid teratomata.

Sequestration dermoids are those which originate in portions of surface epithelium, cut off and persisting in some of the many foldings-in of the ectoderm which take place during the early stages of fœtal development. They may be expected at any place where coalescence of two arches or folds has occurred, as we have seen already in the branchial clefts, or in the median line where these arches meet, or where the plates which form the walls of the trunk, the sides of the scrotum, or the cerebro-spinal canal, join in the median line. As a matter of fact, however, dermoids of the trunk are very rare in front, and almost unknown on the back. In front they have been most frequently seen over the sternum, and in spite of the observations of Bramann and others, who found in some cases a fibrous cord running up towards the neck, indicating that they had migrated thence, it is probable that these cysts usually originate in the line of junction between the thoracic plates; in fact, it is from this source that we must derive those dermoids which occur in the anterior mediastinum. Among recorded

intra-thoracic cases that of Godlee, in which the cavity existed in the apex of the right pleural cavity, and having suppurated was taken for an empyema, and that of White, in which an adhesion had formed to the pericardium, are worthy of note. In both cases the patients expectorated hairs at intervals. The usual seat for dermoid cysts overlying the sternum is rather high up, over the manubrium, but they are occasionally seen lower down.

In the median line of the abdomen they appear to be unknown except at the umbilicus, where two or three have been recorded. Güterbock operated upon one which had suppurated and formed a large cavity just inside of the umbilicus, and perhaps we may admit the cases of Longuet and Villar (quoted by Ledderhose), although it is possible that these were both only instances of umbilical concretion. Along the spine, dermoid cysts appear to be nearly as rare. Sutton figures a small dermoid which lay over two or three defective thoracic spines in a case of spina bifida occulta, and also one observed by Wild, which lay over the sacrum. The latter situation ought to furnish numerous dermoid cysts, because of the frequent occurrence of a congenital sinus in the skin at this point.

But the most frequent situation for dermoid cysts of the sequestration type is about the head, where so many of the developmental foldings of the ectoderm take place. Williams places 41.6 per cent. of all dermoids on the head, more than half of these being situated about the orbit; 35 per cent. in the ovary; 17.6 per cent. in the neck; and the rest scattering. Of the orbital dermoids, the majority are seated near the external angular process of the frontal bone. Occasionally cysts in this locality will lie a little farther away from the eye, or higher up, and they have been found (probably migrated) nearly over the centre of the eyebrow. The next most common situation is the internal angle of the eye, after that the side of the nose, over the glabella, and, finally, directly in the median line of the nose. In the three situations first named, it is readily understood that they occur in the course of the orbito-nasal fissure, between the maxillary process below, the frontal bone plate above, and the fronto-nasal process in the median line. The cysts which appear over the glabella may possibly take their origin in the shallow grooves which very early in fœtal life go to form the olfactory organ. But inasmuch as the fronto-nasal plate is a median structure, it is not easy to comprehend how any epithelial sequestration can take place over it, and pathologists are divided as to the origin of dermoids lying in the median line of the nose. The most probable explanation appears to be that of Bramann, who follows the description of the formation of the bridge of the nose given by Witzel, in attempting to account for the rare deformity of a median cleft of the nose, found associated in a few cases with cleft palate. Witzel says that at a very early period there is a median depression in the fronto-nasal process, lying between two very slight elevations at its lower corners, the prominences which go to form the nostrils at a later period. Then from these prominences two little rounded ridges run upwards, making this central depression still more marked. As development goes on the prominences for the nostrils grow larger, the elevations running up from them on each side approach each other, the cartilaginous septum of the nose develops from the central grooved portion (this cartilage at first is

split in the median line), and the shallow groove disappears, being filled up by the coalescence of these two lateral elevations. As Bramann says, a slight exaggeration of this groove, making it a little deeper, would furnish the opportunity for a sequestration of the epithelium at its base. Congenital sinuses are found here too, showing that there must be a fœtal infolding along this line in some cases at least.

Dermoids are not uncommon about the auricle, and over the mastoid, and when one recalls that the auricle develops from six different prominences clustered around the external meatus, according to His, it is not difficult to perceive how inclusion of epithelium occurs in this locality. Although many have attempted to explain the cysts found over the mastoid process, in the same way as the cysts which occur in other portions of the skull where there are no distinct folds, it appears to me more probable that they are simply auricular dermoids a little displaced, like the similar tumors about the angle of the orbit already mentioned.

Until recently it was considered difficult to account for the dermoids found within the cranium, but we are indebted to Mikulicz for a ready explanation of the occurrence of most of them. Many of these tumors develop in connection with the deep infolding of the ectoderm which takes place to form the internal ear, and Mikulicz includes the cholesteatomata, so common in the neighborhood of the temporal bone, among the dermoids. When the encephalon is divided by the deep fissures which sink into it, the outer envelopes do not follow, except partially between the fore-brain and hind-brain, where the dura mater forms the tentorium. Nearly all of the intra-cranial dermoids, however, lie in connection with the tentorium. We must recollect that the skin and dura are originally in contact, and that the cranial bones develop afterwards between them, and then it will not be difficult to imagine that in some cases at least the ectoderm should follow the dura into this cleft, and a portion of it become sequestrated in that situation. Now among the recorded cases of dermoids in this region we can find all the transitional forms. There are subcutaneous dermoids, with the occipital bone hollowed out by their pressure in the region of the occipital protuberance. There are dermoids lying between the layers of the occipital bone. There are dermoids lying between the dura mater and the bone, with an opening in the latter, and a fibrous band, connecting the sac with the scalp, passing through this foramen. Finally (Hawkins's case) there are dermoids within the dura mater, but connected with the tentorium. Lannelongue has seen a deep transverse fold across the occiput in the skin of a human fœtus—a monster. Less easy to explain are the cases in which a dermoid lies over the anterior fontanelle, often closely simulating a meningocele because it becomes tense when the child cries. Mikulicz is forced here to suppose that a pathological intensification of normal conditions has occurred, exaggerating the shallow grooves which run across the ectoderm along the course of the fissures developing in the brain beneath, and thus giving opportunity for epithelial sequestration. Sutton prefers to explain these last-mentioned dermoids by supposing an adhesion to take place or persist between the skin and dura mater, so that a portion of the latter becomes buried in the gradually thickening tissue during the development of the bone, and thus becomes sequestrated. We note in passing

that intra-cranial dermoids have twice been operated upon successfully, by Turner and Hawkins.

Tubular dermoids are those which arise from the persistence of some part of three of the numerous fœtal canals which normally become obsolete before birth, namely, the thyro-glossal duct, the post anal gut, and the branchial clefts. Dermoids in the last-mentioned situation have already been sufficiently dwelt upon under the head of branchial-cysts. The thyro-glossal duct is an offshoot from the pharynx in the anterior median line, which descends and gives origin, according to His, to the isthmus of the thyroid gland, its orifice being at the point indicated in later life by the foramen cæcum of the tongue. This duct is first occluded at its middle, where it passes through the hyoid bone. The lower portion, shut off from the orifice, sometimes swells up and forms a cyst. If this ruptures or is incised externally, a median cervical fistula will be produced, and Sutton accepts Marshall's view that all so-called congenital fistulæ have originated in this way, and denies the claim of others that they originate like other cervical fistulæ from a pre-cervical sinus or from branchial clefts. The upper portion of the duct, if shut off, is supposed to account for those dermoid cysts which are found in the floor of the mouth in the median line.

Dermoid cysts in the floor of the mouth are not so rare as has been supposed. They have been carefully studied by Ozenne, Lannelongue, Barker, Monod, and Marchant. Barker figures, as does Sutton, a tumor of this sort which projected from the mouth. About one in five or six lies laterally, between the genio-hyoglossus and the mylo-hyoid muscles, and Sutton supposes these lateral cysts to originate from the second cervical branchial cleft. But they might originate from the lateral offshoots of the thyro-glossal duct observed by Bochdalek just above the hyoid bone. The tumors in the median line are generally attached to the hyoid bone, although occasionally they are found connected with the genoid tubercles of the inferior maxilla. They usually occur in young adults from 15 to 30 years of age, and are occasionally mistaken for ranula, but the diagnosis can be made by the free mobility of these tumors, their lack of adhesion to the mucous membrane—in fact they seem to develop in all cases a sort of bursa around the sac, so that they are not attached to any of the soft parts—and occasionally by the fact that they can be moulded and will retain the impressions made on their surface by the finger. According to Hochenegg the application of an icebag will render this last symptom easy of production. When their size becomes inconvenient they should be removed by a careful dissection, if possible without opening the sac, either through the mouth or from the outside; the resulting scar is an objection to the latter method, and as primary union can generally be obtained by the mouth, that mode of approach should be given the preference.

In connection with this duct undoubtedly originate those tumors of the tongue which have the structure of the thyroid gland. Perhaps too we can associate with it the mixed tumors resembling the mixed tumors of the parotid, occasionally found in this region.

The post-anal gut is that portion of the intestinal canal which lies posterior to the point where the external depression which is afterwards to form the anus joins the bowel, for the obliteration of the neuren-

teric canal, which in very early life makes one continuous passage of the intestinal and spinal canals, passing around the tip of the coccyx, takes place farther down than the meeting-point of the anal and intestinal segments of the bowel, leaving a short pouch which subsequently becomes atrophied. Should this pouch persist after being shut off, it would give rise to dermoid cysts in the pelvis, where they are occasionally found between the rectum and sacrum. These dermoid cysts contain hair and teeth, and may attain a large size, even 76 centimetres in circumference. They can be removed by incisions behind the anus. Trzebicky has reported one case of this kind in which the tumor was hour-glass in shape, having one part under the gluteal muscles and another in the pelvis, and refers to three similar cases. Probably the dermoid in the deep tissues of the thigh, reported by Hulke, had its origin in some such way, having been displaced in later life.

Ovarian dermoids take their origin from the oöphoritic portions of the gland, and although the ovary is in its follicles a modified mucous gland, it must be remembered that the distinction between skin and mucous membrane is not as great as at first appears. The mucous membrane of the conjunctiva is really derived from the skin, and occasionally reverts to that structure. In some rodents hair is found on the inner surface of the cheek, and in one species of bird hair guards the pyloric orifices of the stomach. Therefore it is not incomprehensible that dermoids should arise in this locality. The ovarian are the most complex of all dermoids in their structure, so much so that some authors have been led into the supposition of the existence of some sort of autogenetic power in the tissues of the ovary, leading to a kind of monstrous pregnancy. But increasing embryological knowledge has dispelled all such ideas. Another theory derives the dermoid cysts from ectodermic cells which have found their way into the axis cord from which the ovary develops, as it is known that this cord is made up of mesoblastic cells, but in such a way that it would be easy for cells from the epiblast and hypoblast to be also included.

Ovarian dermoid cysts give no particular symptoms, as they are usually of small size, averaging about the bulk of a fœtal head at term, though they occasionally increase to the size of an adult's head. But they are more liable than other cysts to such accidents as rotation of the pedicle and inflammation. Usually single, they are occasionally multiple (although always unilocular), and in about one quarter of the cases occur in both ovaries simultaneously. They are also quite liable to various secondary formations, such as retention cysts of the sebaceous and sweat glands, adenoma originating in the same glands, epithelioma developing on the surface of the cutaneous lining, carcinoma in some of the glandular structures, or sarcoma from any of the connective-tissue group of elements which are present. It has even been observed that a sort of peritoneal metastasis occurs, in which small secondary tumors appear scattered over the peritoneum. The cysts may also coalesce, the contiguous walls opening into each other by pressure, or they may open into some of the abdominal viscera.

Doran and most other authors deny that dermoid cysts are to be found in the abdomen except in connection with the ovary, claiming that the reported cases have been only instances in which dermoids of the ovary had broken free from their pedicles and had become adherent to the

omentum or some other part of the peritoneum. But beside the fact that dermoids do develop as we have seen in connection with the umbilicus, it is impossible to explain the case of Spencer Wells, in which he found a dermoid cyst retroperitoneally in the mesentery, by any such theory. This cyst was of large size and extended deeply into the loin on each side of the vertebral column.

Several cases of supposed dermoid cyst of the testicle have been reported, but Sutton says that he believes them to have been really of scrotal origin. More study is necessary before this question can be decided.

TERATOMATA.—Often classified with dermoid cysts, but to my mind representing a different species of the same genus and more nearly allied to the true teratomata, are those solid tumors which are covered with true or altered skin, sometimes with hair growing from it, and of varying internal structure—usually fibrous, occasionally containing bone, cartilage, and other tissues (even striped muscular fibre, which is said never to occur in dermoid cysts), sometimes with a structure resembling that of the thyroid gland—and which are found chiefly in the neighborhood of the anus or coccyx, and of the pharynx. These tumors are nearly always in the mid-line of the body. In the pharynx they are often connected with the palate, and the hair growing from them marks them at once as of teratoid character (Otto). In connection with the coccyx they have often been called thyroid-dermoids, sometimes congenital sarcomata. In this situation they have the structure of the thyroid gland but they may also contain teeth. Somewhat similar tumors have been found within the rectum in the shape of more or less pedunculated growths, sometimes with very long hairs which annoy the patient by projecting from the anus, and more rarely containing teeth. Both of these varieties spring from the post-anal gut. These teratoid tumors have been successfully removed by operation from all the situations named.

The other teratoid formations—true monsters by inclusion—have little or no surgical interest, and do not properly fall under the head of tumors.

ODONTOMATA.—The odontomata are tumors which originate from some tooth-germ which has gone astray and developed irregularly or out of place, and they should be included with the teratomata because of the similarity of their biological origin, differing from the dermoid cysts only in the later period in fœtal life at which the aberrant germs are thrown off for development. In the brief account given of these curious tumors the classification and description will be taken from Sutton.

Sutton separates odontomata according to the part of the dental tissues which give rise to them, some coming from the enamel-organ, some from the tooth-follicle, some from the papilla, and some from the entire tooth-germ.

The *enamel-organ odontomata* are epithelial, and have been called by Eve multilocular cystic epithelial tumors of the jaws. They are alveolar in structure, and may be made up of masses of small cysts, the cavities of the latter, however, seldom exceeding two centimetres in diameter. The septa are fibrous or ossified, and the growing parts of

the tumor resemble in gross appearances myeloid sarcomata. Microscopically they are seen to be made up of alveoli lined with epithelium.

Four different varieties of odontomes spring from the follicle. The true *follicular odontome* is often known as a *dentigerous cyst.* These cysts arise from retained teeth, the fluid representing that which is normally present in the tooth-follicle, although in very small amount. They usually contain an imperfect tooth, although this may be absent. The walls of the cyst may be very thick, or very thin—crepitating under pressure like a sarcoma of bone—and the tumors are occasionally of very large size. They are found in connection with the permanent teeth, and especially the molars. The *fibrous odontome* is formed by thickening of the fibrous sac of the tooth-follicle, which may be so marked as to make the odontome closely resemble a fibrous tumor, the enclosed tooth being overlooked because it is small or undeveloped. The fibrous tissue may be partly calcified. These tumors are usually multiple, often to the number of four. It is supposed that rachitis favors this thickening of the tooth-sac. If these thickened sacs ossify, a mass of cementum is found surrounding the tooth, and thus the third variety of the follicular odontome is produced, the *cementoma.* These tumors are very common in the horse, where they may attain a large size. The fourth variety of these tumors is the *compound follicular odontome*, which is derived from the form last described by irregular ossification, the tumor then consisting of a sac enclosing numerous small mal-formed teeth, containing all the dental tissues or cementum, or dentine alone, and the number sometimes being very great, even three or four hundred.

Odontomes arising from the *papilla* are called *radicular tumors*, and as the enamel has ceased to increase, they consist only of cementum and dentine. These tumors are rather rare except in the lower animals, and are very apt to suppurate and give the impression of advanced necrosis of the bone with sequestration. They are naturally attached to the root of the tooth from whose follicle they grow.

Composite odontomes spring from the entire tooth-germ, and form hard tumors made up of a mass of enamel, dentine, and cementum. They are usually made up of the germs of two teeth fused together, but so irregularly that it is impossible to distinguish them. These tumors grow sometimes to a considerable size, and like the last-mentioned are usually mistaken for the results of necrosis.

Like the dermoid cysts, odontomata are generally first noticed, or come to operation, in early adult life, although rather later than the dermoids. The diagnosis has very seldom been made except in the case of the follicular cysts, and the tumors are generally mistaken for bone-sequestra, or exostoses, or fibrous or sarcomatous tumors. A careful study of the teeth, to ascertain whether any are missing, would probably help to clear up the diagnosis. These tumors are said to be most common in the lower jaw, but Sutton thinks it probable that many so-called exostoses of the superior maxilla are in reality odontomata.

LIPOMA.

Lipoma is one of the few varieties of tumor to which men are almost as liable as women, Gurlt making the proportion 1 to 1.5 and Stoll 1 to

1.1, though even here some authors make the proportion of women three or even four to one, as compared with men. From five to eight per cent. of lipomata are congenital, not including congenital fatty degeneration and hypertrophy. The congenital tumors are noted for their deep situation, often lying under the fascia, resembling when found on the forehead the dermoid cysts, and like them often being surrounded by a ring of thickened periosteum and occasionally thinning the underlying bone by their pressure, although more usually their attached surface is concave, fitting the convexity of the skull. Of the tumors supposed to develop later in life only a small number (about eight per cent.) lie deeply—Williams finding in eighty cases of lipoma five subfascial tumors, two under the pectoralis major muscle, one under the latissimus dorsi, one in the deltoid, and one under the occipital aponeurosis. It may indeed be questioned whether all of the deep lipomata are not congenital, as from their deep situation they may easily be overlooked until in later life they reach a considerable size. In certain situations they tend to become polypoid, and I find this to be especially common in the flexures of the body and limbs, namely, the axilla, the gluteal folds, the perineum, and the popliteal space. Perhaps the pressure exerted upon them in these situations may have the effect of making them project through the overlying skin. One polypoid tumor has been described as hanging from the back of the hand, a congenital formation. Polypoid lipomata are also found on the intestine and in joints, being merely hypertrophied appendices epiploicæ or villi, and sometimes such tumors break away and float about free in the peritoneal cavity. I have seen one of these polypoid lipomata, the size of a coffee-bean, in the præpatellar bursa, with a long, very slender pedicle. It is worth remarking that of the two hundred cases collected by Williams only five were polypoid. A considerable proportion of lipomata are wanting in capsules; according to Stoll, as much as twelve per cent.

Lipoma is often combined with fibrous tissue or with angeioma, the latter being especially common in the face. Striped muscle fibre is also found occasionally in lipomata, usually in the congenital tumors, and most frequently in the periosteal variety and those occurring in the testicle. But Stoll reports a congenital rhabdo-myolipoma in a sixteen-year-old boy, which was situated at the flexure of the elbow, partly under and partly in the lower part of the brachialis muscle, and lying directly upon the capsule of the elbow-joint, thus contradicting the dictum of some authors that lipomata which develop in muscles do not contain these striped muscle fibres. Gowers discovered in one case a rhabdomyoma combined with lipoma within the spinal dura mater.

Multiple lipomata are probably much more common than would be supposed from statistical reports (which estimate their frequency at from two to four per cent. of all lipomata), for usually in such cases the tumors are too small to require surgical treatment and hence escape scientific record. Sometimes these multiple growths are congenital. At other times they appear to have a constitutional origin, probably nervous or vaso-motor. Thus Buchterkirch and Bumke report a case in which multiple lipomata developed after an injury to the spine:—

A man fifty-six years old fell fifteen feet, being made unconscious by the shock. Diminished sensibility and loss of power in the lower extremities followed and persisted. In two weeks lipomata were discovered on each side of the spine, then

others developed in the epigastrium and in the hypogastrium, and two other symmetrical pairs along the spine. Seven months subsequently, three symmetrical tumors were found in each clavicular and one in each scapular region, as well as a tumor over each deltoid, which, however, proved to be a true hypertrophy of the muscle. The neuropathic symptoms persisted.

French authors have reported of late years a number of cases of symmetrical lipomata developing in neuropathic individuals, frequently associated with a rheumatic diathesis (Mathieu):

Potain reports an interesting case in an old man who already bore several symmetrical tumors, and in whom, after exposure to cold and dampness, a new one suddenly appeared in the upper part of the thigh with the symptoms of a chill and intense pain, swelling at once to the size of an orange, but afterwards subsiding to one-third of its original dimensions. A portion removed by a trocar in the acute stage showed a very œdematous fatty tissue, but autopsy a short time afterward proved all of the tumors to be ordinary lipomata. Potain assumes that the neoplasm began in a sudden localized œdema which afterwards became an organized lipoma, but distinguishes sharply between this form of tumor and the local organized œdema described by other authors, in which the fatty tissue is not so characteristic of lipoma. These symmetrical multiple tumors are frequently diffuse.

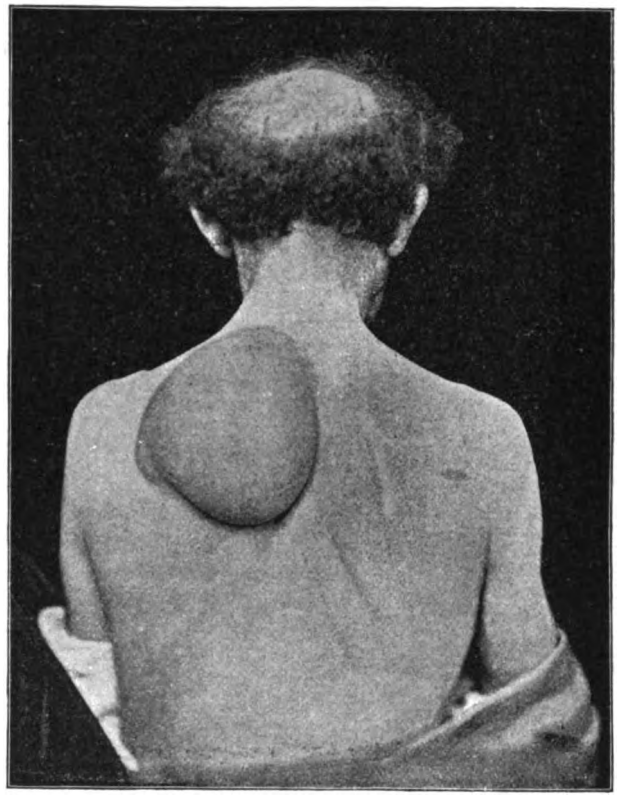
We have already seen that trauma can produce a lipoma, whether from a single injury or by long pressure and friction, and this is held to be the reason why in the rather rare cases of lipoma of the hand it is almost always the right hand and the palmar region that are affected.

Grosch in a careful study of a large number of cases (over 700) of solitary lipoma, partly from the Dorpat clinic and partly from recorded histories, found that the distribution of these growths corresponded with that of the subcutaneous fat (except that they were rare on the abdomen), and varied inversely with that of the sebaceous and other glands of the skin. In the palm, in spite of the absence of sebaceous glands, lipoma is rare, but the sweat glands present enable Grosch to maintain his rule. Stoll, in a study of one hundred and thirty-nine cases, confirms this statement almost absolutely. On this interesting fact Grosch bases the crude theory that because the fat in the blood circulating to the skin is not excreted by the glands, it accumulates in the shape of adipose tissue. But it appears to be far more suggestive to associate this distribution of lipoma with the symmetrical occurrence of lipoma in neurotic individuals, making both depend upon the innervation of these peculiar regions. One might also bring this observation into connection with Cohnheim's theory, for if the development of cutaneous glands and that of lipomata follow the same distribution throughout the body, it would appear that both are under some common law of development and therefore it might be asserted that the fœtal remnants which go to form tumors of this sort are found to occur in some less haphazard fashion than is now generally supposed. In other words, it is not surprising to find such undoubted fœtal productions as dermoid cysts occurring as they do in certain places where there is always some anatomical or mechanical reason to expect them, but it is more difficult to understand why fœtal remnants should occur scattered all over the body without any systematic distribution, as according to Cohnheim's theory must usually be imagined; and this correspond-

ence between the cutaneous glands and the lipomata would indicate that some sort of law controlled even such erratic growths as these.

Sutton has studied the etiology of lipoma from an altogether different standpoint, coming to the conclusion that any of the soft tissues of the body, normal or pathological, may degenerate into fat, and that this retrograded tissue does in some instances assume an autonomy and grow into a fatty tumor. The subcutaneous lipomata he places at once out of consideration, by classing them as local hypertrophies, limiting himself to what he calls true fatty tumors. In support of his theory he advances the following arguments: 1. In a case of parosteal lipoma of the clavicle, a large tumor closely attached to the bone, he found between the bone and the growth a thin layer of striped muscular tissue, and hence assumed that he had to deal with an abnormal muscle which had started to develop from the clavicle, but had atrophied and had become converted into a lipoma. 2. Lipoma, or rather a local accumulation of fat, often forms in the scrotum of castrated animals. 3. Fibrous inflammatory masses may become lipomata, as has been noted in the case of the ureter and Steno's duct, in both instances calculi having been the cause of the inflammation; and also in growths around the rectum, in cases of syphilitic stricture or uterine disease. 4. Extruded omentum in a hernial sac often largely increases in size. 5. In one case a fœtus born at the eighth month, with an injury to the back severing the spinal cord and probably dating from the fifth month, when a severe blow had been received upon the abdomen of the mother, had arrested development of all the parts below the seat of fracture, and a complete fatty metamorphosis of the soft parts, so that there was nothing left except skin, bone, and masses of fat. 6. In certain amphibia (frogs and toads), the anterior part of the genital ridge, from which the testicle and ovary are developed, regularly becomes a mass of fat, a true lipoma, bearing no relation in size to the amount of fat elsewhere

Fig. 1596.



Lipoma of Back.

in the individual, and not diminished by general emaciation. But every one of these arguments and instances, except perhaps the case of the paralyzed fœtus, can be explained in other ways, as by the increased circulation caused in the part by inflammation, by the removal of the testicle, or by constriction and hindrance to the return of blood, and hence this theory must also be dismissed for want of proof; it should be noted, moreover, that in his recent work on tumors Sutton does not allude to it.

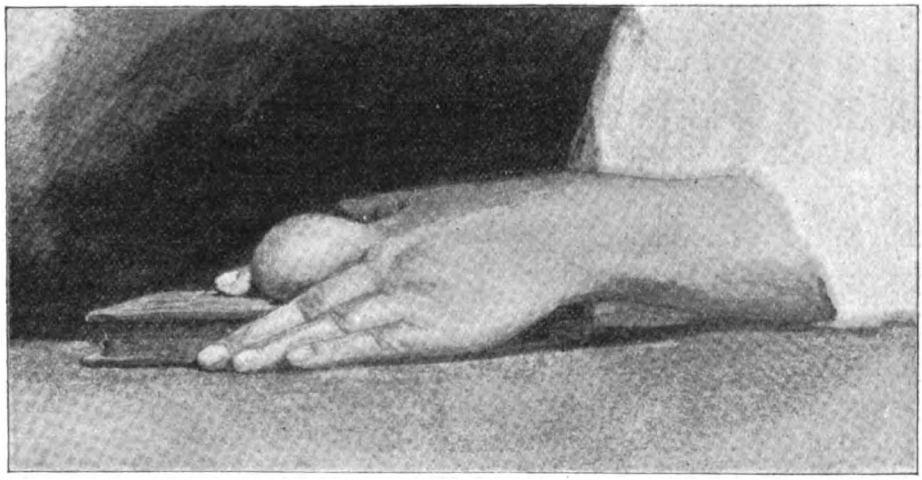
The deep subfascial lipomata often originate in connection with *bones*, being intimately connected with the periosteum. Besides that occurring on the clavicle, noted above, Power has recorded one on the periosteum of the femur, Butlin one on the tibia and fibula, J. Smith and Walsham three on the pelvic bones, Nunn one on the scapula, and J. Smith one on the radius; but they are most frequently found attached to the bones of the skull (Sutton). Occasionally they are seen passing down between the muscles to the vertebral foramina, and even entering the spinal canal (Mayet).

Lipomata are found also in the *retro-peritoneal fat*, between the folds of the *mesentery*, and in the *omentum*. In the first situation they frequently, although not always, spring from the capsule of the kidney. In the mesentery they may be so closely connected with the blood-vessels as to make their separation impossible, without such injury to the vessels as would require resection of the intestine, and this is probably one reason for the high mortality of operations upon these growths—operations which are better left undone, for the tumors cause trouble only by their mechanical effects, and especially by their size, which is frequently great, their weight sometimes reaching even to sixty pounds (Terrillon, Alsberg). These operations are usually undertaken with uncertain diagnosis, and ought to be limited if possible to exploration. The lipomatous growths may invade either the meso-colon or the mesentery proper. Meredith has reported the successful removal of a lipoma of the omentum, a situation in which the prognosis of an operation would naturally be far better. Quite important are the *properitoneal lipomata*, especially those which form near hernial openings, and which are supposed to cause hernia by drawing down the peritoneum with them as they grow outward. Especially to be noted are those tumors of the epigastrium which consist of small masses of properitoneal fat, becoming extruded through apertures in the abdominal muscles and fascia, and appearing under the skin like herniæ. Similar growths have been encountered on the chest, a subfascial external portion communicating with a mass of equal size inside of the ribs (*subpleural*) by a narrow neck passing through an intercostal space. These subpleural growths are very rare, only four cases having been recorded, by Cruveilhier, Morel-Lavallé, Czerny, and Gussenbauer; the last-named surgeon successfully removed the tumor by operation. Sometimes deep *intermuscular lipomata* will have subcutaneous projections, and if the surgeon is not careful to follow the narrow neck inward, and extirpate the deeper part of the hourglass-shaped tumor, a so-called "recurrence" is apt to follow. Eve reports an intramuscular tumor of the abdominal wall in a girl thirteen years old, noticed first at the age of four months and hence probably congenital, which lay between the transversalis fascia and the aponeurosis of the oblique muscles, and which though of large size was successfully extirpated.

The *tongue* is one of the rarer situations for these growths, but the diagnosis is not usually difficult, for the tumors, of soft consistency, lie just under the mucous membrane at the side of the tongue and show their yellow color through it (Kirchoff, Rydygier). Still rarer is the lipoma of the *larynx*, which has been seen only four times clinically, and twice after death, and which may grow to considerable size (a bantam's egg) without jeopardizing life, and is usually pedunculated (McBride).

Rather more common, but equally interesting, are the lipomata of the *hand and fingers*, of which some fifty cases are on record. They are usually found in the palm—there being only two cases on record of a lipoma of the dorsum, and something over a dozen of lipomata of the fingers (Poulet, Steinheil). The diagnosis is quite difficult, the tumor being usually taken for a compound ganglion or tubercular tenosynovitis; but there should be no difficulty in this differentiation, for the

Fig. 1597.



Subcutaneous Fibrolipoma of Finger. Woman, fifty-five years of age. Tumor removed from same situation thirty years ago after seven years' growth. Present tumor of many years' duration. Motions of finger normal. (From a photograph.)

latter affection usually extends above the annular ligament, whereas the lipoma, developing between the skin and palmar fascia, is unable to break through the strong connections between the ligament and the latter. Very rarely a lipoma of the palm extends down upon the fingers, for here too the fascial connections interpose a barrier, although it is not quite so complete. In some cases the fatty tumors tend to grow between the metacarpal bones toward the back of the hand, forming prominences there, a peculiarity which would at once distinguish these growths from the swellings of tubercular tenosynovitis. A considerable number of these lipomata are congenital, about ten per cent. Men seem to be more liable than women, in the proportion of twenty-three to fourteen, and the right hand is three and a half times more commonly affected than the left.

Lipoma of the *sole of the foot* is even rarer, and I know of only four cases on record (Gay, Weil, Löbker). The lesson of the case reported

by Gay is important. A congenital tumor appeared in a child's foot, was partially removed, and grew again. It was seen by another surgeon, who with the history of recurrence naturally supposed himself in the presence of a malignant growth, and amputated the fore-part of the foot; but the pathological examination proved it to be an easily removable lipoma, the recurrence evidently having been caused by imperfect removal at the first operation. [Many years ago the editor saw a case of plantar lipoma successfully operated on by the late Prof. Henry H. Smith.]

Analogous to these lipomata of the palm and sole are the fatty growths which occur in the *tendon-sheaths*, of which five cases are on record (Haumann, Sprengel, Haeckel, Kurz, and Sendler). The peronei and extensor communis digitorum of the toes, the extensors of the thumb and fingers, and the flexors of the fingers were the tendons affected. The disease was symmetrical in three cases; the patients varied from ten to twenty-seven years of age, and appeared to be more or less tuberculous. In several cases the tumors were arborescent, like the fatty growths from the villi of the synovial membranes of joints found in arthritis and tuberculous joint disease, and it is highly probable that they were of tuberculous origin, although no evidence of this could be found on microscopical examination. The tendons were as a rule not affected, although the fatty masses were more or less attached to them, but in two cases they were somewhat thinned. The fatty masses in all but one case seemed to come from the meso-tendons or vinculæ, and to be adherent to the tendons but not to the synovial sheaths, although the latter were greatly distended. In several instances the disease extended above the annular ligament, and it was impossible to make a diagnosis from tenosynovitis, especially as the fat gave a crepitation very closely resembling that of rice-like bodies. There is some probability at least that this affection is really a peculiar form of tuberculous inflammation, or a fatty degeneration of previously existing tubercular or inflammatory deposits.

Lipomata are sometimes found in the *scrotum*, as outgrowths of the spermatic cord, and Hutchinson, Brossard, and Koch have of late placed such cases on record. Park's case of lipoma surrounding the *testicle* is probably to be included here.

Pedunculated and even broad-based lipomata are found in the *joints*, growing under the serous membrane, especially in the knee. Schmolck and Wagner, Lauenstein, and Weir have recently reported a number of such cases. Schmolck has especially called attention to the fact of the occurrence with tuberculous arthritis of the arborescent lipoma which had already been observed in rheumatic arthritis. As curiosities, the *retro-mammary* lipoma in a three-year-old boy, recorded by Löbker, the lipoma of the *broad ligament* successfully removed by laparotomy by Pernice, and that resembling a tail in the *sacral region*, reported by Bartels, should be noted.

Lipomata have been found in pedunculated form in the interior of the *bowel*, and Link removed one successfully which had protruded from the *rectum*. Virchow's case of lipoma occurring under the mucous membrane of the *stomach* is of course well known.

The sucking-pad ("Saugpolster") of the *cheek* has been known to be the seat of lipomatous growth.

The lipomata which develop about *spinal meningoceles* require notice, if only for the danger of attempting removal without recognizing beforehand the existence of spina bifida. Tumors of this nature in the regions where spina bifida occurs, should of course be carefully examined before any operation is undertaken.

FIBROMA.

A fibroma may develop wherever there is connective tissue; it is of all tumors the most universally distributed. The fibrous is very often combined with other tissues in neoplasms—most frequently with fat, unstriped muscle, and glandular elements, among the benign tumors—and it is associated also with sarcoma and, as a stroma, even with carcinoma. Frequently found in cystic form, it becomes so by reason of mucous degeneration, or because of its association with glandular elements. The latter variety of fibro-cyst is most common in the breast, and has even been observed in males in a considerable number of cases; in fact, the cystic variety of fibroma is more common in the male breast than the solid.

Fibroma is very common in the *breast*, but usually there is also enough increase of gland tissue to make the title fibro-adenoma more proper. Seven per cent. of these tumors are developed before the sixteenth year of life, twenty-three per cent. after the fortieth year, and the rest between these ages, so that the disease is one of the active life of the mamma. The solid form occurs earlier in life than the cystic. Pilz reports a case in which a fibroma developed in the nipple, becoming pedunculated, and was removed after four years of growth, having reached the size of a walnut. Leser has shown that a form of cystic tumor occurs sometimes in the breast, in which the amount of fibrous tissue is very small, but in which the walls are covered with several layers of proliferating epithelium, warty growths projecting from them into the cavity, and making a picture which resembles the proliferating cysts of the ovary, rather than the ordinary cystic fibroma. Gross in a study of one hundred cases of fibroma of the breast found a history of injury in one case out of every seven.

Among unusual situations for fibromata the *tongue* should be mentioned, for here they are almost as rare as lipomata (Kirchoff). Clinically they have no importance in this situation except as a possible source of irritation and consequent carcinomatous development. A pedunculated fibroma in a woman's *urinary bladder*, where it had attained the size of a turkey's egg, has been reported by Bazy. Only two cases of fibroma developed from the *spermatic cord* are on record, so that it is even rarer than lipoma in this situation (Brossard). Kirmisson reports an instance in which symmetrical tumors developed in the *tendo Achillis* on each side in a young man, existing for years without symptoms; as they were unaffected by mercurials, and as the patient afterward acquired primary syphilis, it was pretty certainly demonstrated that they were not gummata, so that the diagnosis of fibroma appeared the only one which was justifiable, in spite of the fact that fibroma of tendons is so rare. Sendler reports the case of a man forty-two years old with a fibroma of the tendon of the *palmaris longus*, re-

moved by operation after five months' growth, when it was three or four centimetres long and had caused trouble by pressure on the median nerve. Fibroma may occur in the *gastro-intestinal tract.* Thus Senn records a case in the *rectum.* Sutton has observed annular fibroma in the *duodenum* of a mare, and pedunculated fibrous tumors on the external surface of the *stomach* of the cow, and also of the codfish. Fibroma, by the way, is quite common in the lower animals, and is occasionally melanotic, especially in horses and cows, although even then it runs a benign clinical course. All of these fibromata in the intestinal canal are really fibromyomata.

Among the curiosities of the subject we may note the great rarity of fibrous *pharyngeal* polypi in the female sex. Pluyette, in an exhaustive search, was able to find only nine well-authenticated cases of the kind, notwithstanding the frequency of this affection in males.

Multiple fibromata are frequent in the *skin* and are usually of the variety known as *fibroma molluscum.* Taylor has recorded a case which was under observation for many years, and which clearly showed a cycle of development and retrogression in the tumors. He says that the first appearance of the tumor is shown by a softening and slight projection of the skin at some point. Pressure on the latter renders it possible to invert the growth as it were through an apparently softened spot in the corium. As time goes on the projection becomes greater, until the tumor hangs on a sort of stalk, during which time it becomes increasingly difficult and finally impossible to invaginate it, owing apparently to the concentric contraction of the softened spot in the derma. The tumor then begins to shrink, its fibrous body apparently atrophying until the outer sac of skin or epidermis is the only part left; this hangs for a while like an empty pouch, until it in turn shrivels and becomes a sort of wart. This involution of the molluscum is exceedingly interesting, and is only another instance of the contraction characteristic of fibrous tissue everywhere, even as a beneficent constituent of carcinomatous tumors. One question unsolved in these cases of multiple fibromata of the skin is their origin. The supposition originated by Virchow and von Recklinghausen, that they always originate from the fibrous covering of the nerves, appears to gain in strength, although there are still good observers who claim that they may come from the arteries and skin-glands as well. The latest writer on this point, Goldmann, however, says that these opinions have been held only because the observers have overlooked the fact that in both glands and blood-vessels there are contained minute nerve-fibrils from the sheath of which these little tumors might have originated, while yet seeming to have come from the connective tissue of the vessels and glands themselves, the fibrils being too small to be detected.

Fibrous tumors of the *nerves*, originating from their sheaths, or more properly speaking from the endoneurium, are rather uncommon tumors, and it is only recently that any satisfactory results have been obtained in their study. Let us first recapitulate the facts of the anatomical structure of the nerve sheaths. The nerve fibres are each surrounded by a connective-tissue sheath, the endoneurium, and each bundle is also enveloped in a common sheath, the perineurium. Key and Retzius have demonstrated that injections of the lymphatic spaces within the perineurium never penetrate beyond it into the neighboring lymphatics,

although on the other hand the perineural spaces are connected with the canals of the central nervous system, and consequently the nervous lymphatic circulation is entirely shut off peripherally from the general lymphatic system. Even the single terminal nerve fibres have separate perineural spaces which are of considerable width. Goldmann finds that in cases of fibroma of the nerve sheaths—fibromatosis, or congenital elephantiasis of the nerves, as it is sometimes called—the growth of fibrous tissue takes place from the endoneurium, and furthermore that it is not a mere overgrowth of the ordinary fibrillar connective tissue, but that it consists of well-developed new connective tissue, and also of trabeculæ formed by myxomatous cells with branching processes which either interlace or terminate in some of the connective-tissue fibres. The extraordinary richness of this tissue in cells and nuclei shows that this is not a condition of mucoid degeneration, but rather a true embryonic state of the connective tissue, which is almost exactly paralleled in structure by the fœtal dura mater. Hence the conclusion is legitimate that the disease is rather a congenital deformity, a persistent fœtal condition of the endoneurium, than a true neoplasm. Owing to the encapsulation of this new growth by the perineurium it never spreads to surrounding parts.

These tumors may be single, but generally are multiple, and usually attack the majority of the branches of a certain nerve. Sometimes the entire nerve stem and its branches are proportionally enlarged and thickened, and this condition may involve all of the cerebro-spinal peripheral nervous system. In some cases the change is greater at certain points, forming true tumors, but in others all the peripheral branches of a nerve trunk will be so enlarged as to form a mass of vermiform swellings under the skin, like a cirsoid aneurism, the so-called "plexiform," or "Ranken-neuroma." Pomorski has reported an extraordinary case of cirsoid nerve fibroma which originated from the intercostal nerves, and filled two-thirds of the pleural cavity of the corresponding side of the chest, the tumor having caused no symptoms, and only being discovered after the patient's death. The skin itself over the superficial nerve-tumors may be unaltered, or may be apparently uniformly hypertrophied, even although the microscope shows that this uniform thickening really depends upon a very large number of minute fibromata developed from the terminal filaments of the sensory nerves. In a case of this kind Goldmann found that all the fibromata originated from the nerve-filament sheaths, and says that he believes that this is always the case, though former observers supposed that they sometimes came from the blood-vessels and glands of the skin, overlooking the fact that even in these cases the true origin of the growths was from the minute nerve-filaments which supplied these organs. The nerve fibres have been reported by some observers to have been atrophied, but Goldmann thinks that this is exceptional, and that it perhaps never occurs unless some malignant change has taken place.

Clinically, these tumors are as a rule so innocent that they are not recognized unless they attain a considerable size, giving rise neither to pain nor to paralysis of either sensation or motion. The disease is most common in the head and neck, next in the trunk, and rarest in the extremities, though it does occur in the latter, more frequently in the upper than in the lower extremity, and more often affecting the

median than any other nerve of this part. The changes never reach farther toward the centre than the points of exit of the nerves at the vertebral or cranial foramina. The optic nerve appears to remain unaffected in all cases, and usually the auditory nerve also, facts which Goldmann tries to explain by the development of these nerves at an early stage in fœtal life. Although both forms of nerve may be affected, the sensory is the most frequently attacked. Besides the fibromata of the skin already noted, abnormal pigmentation, elephantiasis, and lymphangeiomata are often associated with the disease. The cirsoid form makes external tumors which to the sight resemble hypertrophic folds of skin, similar to those seen in elephantiasis, but to the touch the worm-like feel of the bulbous nerve-ends within is characteristic. Consistently with their congenital origin the tumors are usually observed in early life, although they may not be noticed until later, and this is especially true of the single growths.

When these tumors are extirpated, they sometimes return like malignant growths. Still oftener one of them may suddenly develop symptoms of malignancy in rapid growth and pain, and on removal will show a distinct sarcomatous structure, recurring also at the original seat of disease, but rarely if ever giving rise to metastasis.

KELOID.—Among the fibrous tumors must be included the peculiar outgrowth so often associated with scars, called keloid. Of late years the tendency among authors has been to disregard the distinction formerly drawn so closely between true or spontaneous keloid and the false keloid or hypertrophied cicatrix. There is a certain slight histological difference between the two, but otherwise they are alike, for the mere fact that one originates in a scar and that the other is supposed to arise independently will scarcely answer as a reason for holding them apart, since the so-called spontaneous form may actually have started in some minute cicatrix, it being already well known that even the scar of an acne pustule may frequently be the source of origin of a large keloid growth. Both sexes are liable to keloid, which is rare in infancy, although Bryant and Volkmann are said to have each observed a case which was congenital, and Vidal has seen it develop in a child three months old in the cicatrix of a vaccination-pustule.

Keloid is often symmetrical and multiple, and is most frequent over the sternum, and on the shoulders, buttocks and arms, while it is rare on the legs. In some cases it seems as if there were an hereditary influence. It has been claimed that keloid is especially frequent in cases of syringo-myelia, but in six successive cases of this disease Leloir and Vidal found no instance of keloid formation. Keloid is more common in the African race than in others, and I have seen one case in an old negro woman where the entire body was covered with huge welts of unknown origin. In this case the tumors were elongated, slightly curved, following the natural skin folds, and many of them were several inches long, an inch or more wide, and an inch in height. The masses were very uneven on the surface, like the rough bark of a tree, and in fact the patient's body reminded one forcibly of the trunk of a tree with lichens growing upon it. Hayes reports a similar case, and although Warren criticises the classification of such tumors with keloid, their clinical history resembles it so closely that in spite of the differen-

ces in external appearance it appears to me wiser to admit the warty or papillary variety as a keloid growth. The typical keloid, however, is a hard, smooth tumor, and is usually red or pink in color, although it is said occasionally to be white. It is usually an oblong patch, slightly elevated above the surface of the skin, with extensions at various points stretching out over the neighboring skin like claws, and from these projections it gets its name. This form of the growth is rare, however, Hebra having seen it only once in two thousand cases of skin disease. Verneuil has reported a case occurring in the conjunctiva, so that keloid may occur even in mucous membrane.

Microscopical examination of these tumors reveals a true cicatricial structure, made up of bundles of interlacing fibres, running horizontally just below the upper surface of the corium. In false keloid, just as in any ordinary cicatrix, there is a complete absence of papillæ, for these are seldom if ever reproduced when once destroyed; but in the true keloid the papillæ are usually perfect, the growth infiltrating the corium beneath them, and only rarely destroying them, probably by the mechanical effects of its pressure. The blood-vessels in and even beyond the growth show certain changes, being surrounded with round cells which infiltrate the adventitia, while many fusiform cells are also found surrounding the vessels. The glands of the skin are destroyed in both varieties of keloid. Warren says that the keloid begins by a growth of round cells in the adventitia of the arterioles of the corium, these cells afterwards becoming fusiform in shape, and finally developing into fibres which coalesce and form the tumors. One theory of the pathology of these growths is that they are really myomatous, the fibres being bundles of unstriped muscle fibres.

Although keloid is usually easy of *diagnosis*, sarcoma may sometimes be mistaken for it, as is illustrated by the cases reported by Taylor and Jacobson.

The treatment of these scar-tumors is very difficult. When small they may be excised with a wide margin of healthy tissue, and a cure will usually result. Skin-grafting by Thiersch's method might be tried after excision of the larger growths, as there appears to be very little tendency to contraction or hypertrophy after such grafting. One of the most successful methods of treatment is cross-barred scarification, as suggested by Vidal. Local anæsthesia is employed, and with a sharp knife parallel incisions are made, extending through the entire thickness of the growth and a short distance beyond its edges on every side, and these incisions are then crossed by a second similar series at right angles or obliquely. The rationale of this treatment would appear to be the encouragement of a new formation of blood-vessels in the granulation tissue which fills up the little cuts, and the absorption of the surrounding fibrous tissue, just as it melts away in the indurated edges and bases of chronic ulcers similarly treated by "cross-hatching" incisions.

CHONDROMA.

Very interesting is the independent observation by Virchow and by Bland Sutton of the frequent association of enchondroma with rickets, and the explanation that this association is due to irregular ossification of

the epiphyseal cartilages. Sutton figures islands of cartilage which have been left unchanged in the epiphyseal line completely surrounded by bone, ready at the call of any irritation to spring into independent being and form neoplasms. The common occurrence of enchondromatous tumors in the neighborhood of epiphyses, and their frequent multiplicity, are thus also explained. The whole forms an additional argument in favor of Cohnheim's hypothesis.

As to the *situation* of chondromata, Williams gives us the information, based upon an analysis of seventy-two cases, that thirty-eight per cent. (Gurlt says 21.5 per cent.) occur in the parotid, twenty-two per cent. (14.6 per cent., Gurlt) in the hand, twenty-two per cent. (13 per cent., Gurlt) attached to the long bones, three per cent. (5 per cent., Gurlt), in the superior maxilla, five per cent. in the submaxillary gland, and the rest in the lower jaw (Gurlt, 8 per cent.), breast, testis, ischio-rectal space, toe (Gurlt, foot and toes 18 per cent.), scapula, external ear, and mediastinum. From the mention of the salivary glands it is evident that no attempt has been made by Williams to sift out of this list the mixed tumors, and probably Gurlt's figures more nearly represent the frequency of pure enchondromata.

Berger has provided us with a careful study of this form of tumor in the *upper jaw*. Quoting Weber's figures of only fifteen cases of chondroma in the upper jaw out of a total of one hundred and ninety, he adds that he easily collected thirty cases but had to eliminate all but eighteen, as the rest were not pure chondromata, the cartilage being mixed with bone, fibrous tissue, or sarcomatous tissue. The pure chondroma of the upper maxilla is as a rule a slowly growing tumor, not infiltrating the surrounding parts, or infecting glands or distant organs, but it recurs very frequently, in fact almost universally, unless the removal has been unusually thorough. This last peculiarity, and the ultimate extension of these growths by contiguity to the base of the skull, or to some other part in which they can no longer be treated by operation, gives them a semblance of malignity. But if the surgeon can bring himself to remove the entire superior maxilla at the first operation, recurrence will not take place, and this should be the rule in dealing with all such tumors, no matter how small and limited they may appear.

A few cases of enchondroma in connection with the *larynx* have lately been added to the list by Putelli and Böcker, bringing the number of undoubted cases recorded in this rare situation up to eight. Marsh has reported a curious case in which an enchondroma formed on the tibia just outside of the synovial membrane of the *knee*, directly under the ligamentum patellæ. Haberern relates a case in which an enchondroma formed at the seat of a fracture through the condyles of the *humerus*, the first symptom observed being severe pain beginning six weeks after the patient had been dismissed from treatment with a consolidated fracture, and the tumor being first noticed nine months subsequently. The extremity was removed by amputation, and the tumor was found to be a cystic enchondroma. Of seventeen cases of callus-tumor collected by Haberern, five were sarcomata and seven chondromata. He suggests associating these tumors with the chondromata observed in rickets, and explaining them by irregular ossification of the callus. Several congenital cartilaginous tumors of the *neck* have

been placed on record by Bidder, Grimm, Barker, and Sutton. While most authorities are inclined to accept these as remains of branchiogenic origin, Sutton maintains that they are misplaced, rudimentary, supplementary auricles, such as are found in certain animals.

Very extraordinary is the occasional simultaneous occurrence of multiple enchondromata and multiple angeiomata. Two extreme instances of this curious affection are now on record, the earlier case of Kast and von Recklinghausen being exactly paralleled by one reported by Steudel from Bruns's clinic. In this case the unfortunate patient began to develop cartilaginous tumors on the fingers in his seventh year, and they continued to appear in other situations and to increase in size up to his death at the age of forty-five. He had insisted upon the amputation of his right hand in his twentieth year, finding the weight of the gnarled tumors too much for comfort. At his death growths were detected on the right shoulder-blade, arm, and forearm, on the left hand, and on all the bones of both lower extremities, besides the skull, ribs, vertebræ, and pelvis. The left arm and forearm remained free. The affected bones were increased to many times their natural bulk, especially near the epiphyseal lines, and many of the internal organs were displaced by pressure. The affected bones had not grown to such full length as the others, and various deformities showed irregular growth. The tumors were softened and cystic in some places, and nowhere ossified. Metastases existed in the lungs, probably originating from a growth in the abdomen which had caused thrombosis of the iliac vein. The angeiomatous tumors had developed in the later years of life, for at the patient's twentieth year only one was visible. They were peculiar in that they were formed apparently in the walls of the veins, and seemed to be due as a rule to obstructed circulation, and yet they were true angeiomata and not simple varicosities.

OSTEOMA.

Williams in 111 cases found thirty per cent. subungual (great toe), sixteen per cent. on the femur, twelve per cent. on the tibia, nine per cent. on the humerus, four and one-half per cent. on the vertebræ, and the rest scattered in smaller numbers. Ten per cent. of the patients had multiple tumors. Multiple exostoses are of the cartilaginous variety, that is, are covered with a layer of hyaline cartilage, from which comes their growth, and behind which they ossify. In 15 cases which Bessel-Hagen observed personally, and in 13 others reported in surgical literature, he found a reduced growth of the affected bones, and he even thought that the reduction was proportionate to the size and number of the tumors. He considered it the rule for the tumors to develop from the epiphyseal junction, and to be left behind as the bone lengthened and the epiphysis moved farther on, so that finally they would be situated some distance up the shaft. He found also a marked hereditary tendency in the affection, only two of his patients being without a family history of the complaint, while in one family seven cases had occurred. Men were apparently more liable to the disease than women, and yet the latter were not exempt, for of thirteen cases he found four in females. The bones vary in predisposition; thus

the ulna is more commonly affected than the radius, and the fibula than the tibia. The tumors are more common on the left than on the right side of the body. To Volkmann must be given the credit of having first noticed the association of multiple exostoses with lack of growth of the bones. Reulos reports a family with a remarkable history of these growths, already referred to in discussing the question of heredity, and Seidel, Bonde, and Rubinstein report similar cases. Rubinstein denies the truth of the law announced by Bessel-Hagen, that the defective growth is proportionate to the number and size of the tumors, and also notes that in his case one of the original neoplasms still remained at the epiphyseal line, instead of being carried farther up the shaft in the lapse of time. In Seidel's case, from Volkmann's clinic, a large osteoma had fused together the radius and ulna near the wrist, and, owing to the defective growth of the ulna, the radius had outgrown it to such an extent that at both ends it projected beyond its companion, the head of the radius being actually dislocated upon the humerus. Bonde recommends operation in these cases by local extirpation of the growths, claiming that if the base is thoroughly gouged out the tumors will not return, and that amputation can thus be avoided.

Among the rarities of bony tumors, Trélat reports two cases of subperiosteal osteoma of the *lower jaw*, one in a boy eight years of age, the other in a man. The tumors were strictly limited, of healthy cancellous new bone, and growing slowly without any signs of inflammation, although one was painful. Weinlechner reports an osteoma the size of a chestnut which grew from the outer surface of the *mastoid process* in a woman. A very great rarity is the case of osteo-chondroma of the *mamma* reported by Lesser. It had a typical spongy bone structure, with trabeculæ, and some cartilaginous but no other tissue, and occurred in the breast of a woman sixty-seven years of age, where it had been growing for sixteen years and had attained the size of a man's fist. Although cartilaginous and even bony spots are not uncommon in tumors of the breast, especially in the sarcomata, and although chondroma of the mamma is a common tumor in the female dog, Cooper's case of chondroma of the breast in a woman is the only instance of a tumor at all parallel to this.

Numerous cases of osteoma of the various *nasal* and *frontal* cavities have been added of late to those already reported, and Fenger adds one to the list of cases in which such a tumor had become necrotic. The prognosis of operations undertaken for the removal of these formidable tumors is constantly improving, all the recently recorded cases having ended in recovery.

MYXOMA.

If we except the ordinary nasal and aural polypi, true myxoma appears to be one of the rarest of tumors, Gurlt finding only four cases in his collection of nearly seventeen thousand. Williams appears to have been more successful, giving a list of twenty-nine, of which eight occurred in the thigh and groin, and four each in the mamma and parotid, the rest being perinephric, or occurring in the testicle, palate, nasopharynx, neck, finger, nose, arm, etc. Perhaps the English are not

as strict as the German pathologists in their limitations of the term, many tumors which are called myxomata being really sarcomata with myxomatous portions. In the lower animals Sutton knows of only one authentic case, which occurred in the bladder.

Gould has reported a case of perinephric myxoma, without a trace of fatty tissue. Richot has described a case in the testicle, but it contained some cartilaginous spots and some collections of epithelial cells, so that one is inclined to call it sarcoma, and yet the patient remained well, for recurrence had not taken place two years after removal. A very curious case is that of a tumor which occurred in the mamma of a woman forty-six years of age, described by Jüngst. It had first been noticed ten years before removal, being at that time the size of a hazelnut, and had grown slowly for the first eight years, then more rapidly, until it had attained the size of a man's fist. It caused no symptoms until it was of large size, when it presented the appearance of a hard nodular tumor without adhesions to the surrounding parts. Microscopically it proved to be a myxoma growing in an intracanalicular manner, with hyaline degeneration of its tissues. Myxoma has been observed to grow in this way, and hyaline degeneration is not uncommon, but the combination has not been noted before, and the intracanalicular form is a rarity.

MYOMA.

Myoma has been observed made up of both forms of muscular tissue, the striped and the smooth fibres. The striped-muscle tumors, or *rhabdo-myomata*, are very rare, and most frequently of teratoid origin. The attempt has even been made to show that all such tumors are of direct fœtal origin, but not as yet with success. Striped muscle fibre is most frequently found in combination with other tissues, forming only part of the tumor, and we have already noted how frequently it is associated with lipoma. Gowers has even found a growth of this description lying upon the spinal cord, beneath the dura mater. It is more commonly seen in combination with sarcoma than in benign tumors. Besides these mixed tumors, there are four cases on record of pure or nearly pure rhabdo-myoma of the testicle—that of Rokitansky, published in 1840, and the more recent examples recorded by Neumann, Arnold, and Ribbert. In two of the cases the patients were only three or four years old, and in the others they were thirteen and eighteen years of age. The theory is advanced that these tumors originate from the gubernaculum testis of Hunter, and the occurrence of cartilage in some of them, together with the youth of the patients, indicates a congenital origin. In the other cases the growths were small, but in Arnold's case the tumor was ten centimetres long and twenty-seven in circumference at its largest part. Arnold found that the tumors contained glycogen, which is present only in striped muscle, especially in the embryonic stage. Mrcahand had already noted this in a growth occurring in the pelvis.

A few cases of unstriped muscle tumor (*leio-myoma*) of the *epididymis* have been recorded recently. The first case of this kind was that reported by Rindfleisch, in 1860, since which time there appear to have been none observed until those recorded by Héricourt and Condamini.

All occurred in men between thirty and fifty years of age and were of long duration, the growth in one case increasing rapidly after a blow, in two cases attaining the size of a nut only, but in the others the size of a mandarin orange, and accompanied by hydrocele. The tumors were hard, sometimes smooth on the surface, sometimes nodular, and painless. Histologically they were *fibro-myomata*, and were supposed to have originated from the muscle cells of those deep fibres of the cremaster which penetrate even to the rete testis, called by Henle the cremaster internus. It seems not improbable that these tumors are more common than the few reported cases would indicate, for in their clinical history they are so indolent that they might easily be mistaken for the inflammatory nodules of the epididymis which are so common after gonorrhœal infection.

Another rare situation for myomata is in the *breast*, but no recent case has been recorded to parallel Virchow's (quoted by Schuchardt), in which the growth occurred in the mamma of a man thirty-two years of age, in the shape of a dozen indolent tumors the size of a cherry, of thirteen years' growth, and proving histologically to be pure leiomyomata.

Myoma has not infrequently been observed in the *stomach* and *intestines*, and perhaps some at least of the annular fibromata met with in these situations have really belonged to this class of new-growth. According to Virchow they are more common in the stomach than in the bowel wall, and to the five cases already on record Kunze adds two more, one of which caused symptoms by its size, and led to the performance of laparotomy. Böttcher describes two forms of these tumors as occurring in the intestine, one polypoid, the other annular. The annular form is made up of fibres both from the circular and longitudinal muscular coats of the gut. Senn successfully removed from the pelvis an intraperitoneal fibro-myoma, which had grown subperitoneally from the anterior wall of the rectum, and weighed twelve pounds. He had once seen a similar small tumor growing from the anterior wall of the bowel lower down, in the recto-vaginal septum, but could find no parallel case in surgical literature, although Sanger is said to have operated upon an intraperitoneal tumor resembling that of Senn's first case, the operation not having been published.

Myomata are not infrequently found in the *skin*, but seldom as single tumors. Babes classifies them according to their origin, from the blood-vessels, from the arrectores pili, or from the deep muscular layer of the skin. The single tumors have been observed by Virchow, Förster, and others, and are most common in the scrotum, mammary gland, and labia majora, where they may attain a very considerable size. A transition form between the single and multiple varieties seems to be shown in the case reported by Hess, in which a dozen little wart-like tumors grew in the skin of the nose, the rest of the body being free from them; when excised, they proved to have originated in the muscular coat of the blood-vessels. The multiple form is more common. Curiously enough, four out of five recorded cases (Jadassohn) occurred in women, and on the extensor surface of the arm. They may occur very early in life, and may cause no inconvenience, or may be very painful, as in Hardaway's case. They form smooth, round, hard tumors, lying in the skin, and are usually of very small dimensions.

Polaillon reports a case in a woman fifty years of age in whom a large myoma developed from the posterior wall of the *bladder*, and was removed under the supposition that it was uterine, a vesical fistula developing in the pedicle. An autopsy afterward showed that it had really originated from the bladder wall. Gibbons and Parker successfully removed a myoma from the bladder of a girl eighteen years of age.

Myomata are found in the *broad and round ligaments* of the uterus, both of which contain unstriped muscular fibres, and, very rarely, in the *Fallopian tube*. When arising from the round ligament, they may grow in the inguinal canal entirely extraperitoneally, and may attain the size of a cocoanut.

NEUROMA.

Virchow long ago made the distinction between true and false neuromata, the former being composed of a true new-growth of nervous elements, either ganglionic or fibrillar, and the latter comprising those tumors which develop in or on nerves, but consist only of fibrous or other tissues, with no increase, or even with a diminution, of nerve tissue. As the latter are usually considered under the head of neuroma, it is necessary to mention them here, although a full description of them has already been given under the head of fibroma, where they properly belong. Tumors composed of true newly formed nerve-fibres are great rarities, and Goldmann even questions whether such growths exist. Even those which are found on the ends of divided nerves, especially in amputation stumps, where nearly all previous observers had claimed to find a growth of nerve-fibres, gave to his more thorough methods of examination a negative result. The older observers had no satisfactory *technique* for examining these tumors, and while among recent writers Krause has claimed to have demonstrated an increase of nerve-fibres in sarcomatous growths of the nerve, Goldmann denies the validity of his proof, especially since he was unable to positively demonstrate any point of division of the primitive nerve-fibres.

If all writers would follow Mr. Butlin's example and include these tumors under the head of fibroma, the undesirable terminology would soon die out. Even the word neuro-fibroma applied to these growths is incorrect. They might be called nerve-fibromata, but have no right to the misleading term neuro-fibroma, which implies that they contain newly formed nerve-tissue.

ANGEIOMA.

Gessler collected 1178 cases of tumors of the blood-vessels, and found that seventy-six per cent. occurred on the head, eleven per cent. on the trunk, nine per cent. on the extremities, and three per cent. on the neck. Of Williams's 94 cases fifty-five per cent. were found on the head (Gurlt gives sixty-seven per cent.), and twenty-one per cent. on the trunk. The disease is congenital in nearly all cases, as is shown by the fact that of Gessler's own 213 cases, 139 were in persons under five years

of age, and only 12 in those over thirty. He also found that it was more than twice as common in the female as in the male (2.4 to 1), although Gurlt in 194 cases found a proportion of only 1.4 to 1.

Hildebrand reports a case of multiple angeioma in a young woman, the tumors being located chiefly on the left *arm and hand*, and the thumb having degenerated into a mere mass of vessels. In one of the tumors removed from this patient he found a direct communication with a neighboring vein through a small branch, and another vessel leaving the tumor on the other side, which he took for an artery; no other branches passed out of the capsule of the tumor save these two, so that it lay between the artery and vein almost like an arterio-venous aneurism.

Mastin draws attention to those unusual and yet not very rare cases of angeioma of the *scalp*, either subcutaneous or subfascial, in which a communication exists between the tumor and the intra-cranial sinuses, usually the longitudinal. He adopts a classification of congenital, spontaneous, and traumatic. The first class is probably the most common. The causes are a varicose condition of the venæ emissariæ, or of the veins of the diploë; local disease of the wall of the sinus, causing bulging and pressure on the bone; rarefying osteitis destroying the bone and allowing the sinus to bulge outward; and finally traumatic causes, such as fracture of the skull with simultaneous rupture of the sinus, and the formation of a hematocele communicating with the sinus and preserving its connection. The last cause makes a blood-cyst. The others may result in the production of the varicose, the most common form, or of a true cavernous variety. The condition, when it exists, is recognized by the changes in size due to pressure on the internal jugular vein, and by the compressibility of the tumor when all external vascular connection is cut off, as by the pressure of a ring. The treatment is operative, but the greatest care must be taken to avoid infection, for there have been many instances of operation under these circumstances causing death by sepsis, on account of the intimate connection with the sinus.

Intracranial angeiomata are not very rare tumors, although unusual, and they are beginning to assume importance in these days of cerebral surgery. They usually if not invariably develop in connection with the membranes, and give symptoms similar to those of other brain tumors, —Jacksonian epilepsy, local palsies, etc.—and have several times been successfully removed by trephining, as in the cases of Bremer and Carson, of Péan, of Jeannel, and of Poirier.

Angeioma of the *tongue*, large enough to form a distinct tumor, is comparatively rare, and I therefore mention Fischer's case, in which there was so much fibrous tissue as to warrant the name of angeiofibroma. Very small angeiomata of the root of the tongue have been observed after death by Yersin. Keimer reports one of the *soft palate*. In my experience these nævi of the mouth are usually associated with similar conditions of the neighboring parts of the face, and sometimes with that form called angeioma lipomatodes. Another instance of angeioma of the mucous membrane is the rare case reported by Barker, of a cavernous angeioma occupying one side of the wall of the *rectum*, just above the sphincter, in a man forty-five years of age, who had often suffered from hemorrhage of the bowel, and who finally died of

anæmia brought on by a succession of bleedings due to some small ulcers in the affected region.

Sutton reports another rare case—an angeioma in the *mamma* of a lad seventeen years old—which began as a nævus just below the nipple, when he was a child, and grew slowly until it measured three and one-half inches in diameter and had invaded the breast, when it nearly cost the boy his life through hemorrhage caused by an accidental injury. With this must be placed Sendler's curious case in which an angeioma the size of a two-thaler piece hung from the *nipple* of an unmarried woman, forty-five years of age, by a pedicle as thick as a raven's quill and one centimetre long. It was of congenital origin, and of steady, slow growth, and was covered with normal skin. The patient said that it swelled up and discharged a brownish fluid through the nipple during menstruation.

A very unusual combination-form of angeioma is that reported by Lücke, namely, an *ossifying angeioma*. This tumor, composed of angeiomatous and osseous tissues, both in a state of progressive growth, the ossification apparently following the extension of the angeioma, occurred in the antrum of Highmore of a woman twenty-six years of age, who had noticed pain and swelling of the jaw for one year previously. The growth was removed, and examined by Recklinghausen. Djakonow had previously recorded a case of similar tumor, except that this also contained myxomatous tissue, which developed in the course of two years, after a severe blow, from the orbital ridge of the frontal bone in a young woman twenty-one years old. This tumor had also been successfully removed. As was to have been expected, the hemorrhage was terrific in both operations.

LYMPHANGEIOMA.

The tumors formed of lymphatic vessels differ from those of the blood-vessels by their tendency to form cysts. They may be classified under three forms, simple or varicose, cavernous, and cystic. The "tuberous" form observed in the skin by Kaposi differs from the simple only in the thickening of the walls of the vessels, giving the tumors a firm, incompressible character. Their etiology is uncertain, but these growths are probably dependent upon some congenital vice of formation, or tendency to increase of the lymphatic vessels, just as in the case of the hæmatic angeiomata. Bessel-Hagen would include in the lymphangeiomata only those lymphatic swellings in which there is no obstruction to the circulation, naming all others lymphangiectases. A practical difficulty arises in distinguishing these two classes, but Nasse judiciously suggests that we should admit among the lymphangeiomata every tumor in which the obstruction cannot be demonstrated.

Histologically these tumors consist of lymphatic vessels of all sizes, lined with endothelium. There are often round cells just outside of the growths, sometimes in large numbers, but not infiltrating the intervening connective tissue, and apparently not leucocytes. These cells are supposed to be angeioblasts, and their discovery appears to render it certain that we have in these tumors a new formation of vessels, not a mere distention of preformed channels. In fact, in the skin, lymph spaces appear in the papillæ where normally there are none.

Newly formed lymphatic tissue, with the addition of fibrous or fatty tissue, when it occurs diffusely in the tongue and lips, gives rise to the deformities known as macroglossia and macrocheilia. Some cases of elephantiasis appear also to be due to neoplastic changes in the skin, rather than to a mere obstructive lymphatic œdema. The more circumscribed simple or cavernous tumors have similar aspects to the blood-angeiomata. They are found all over the body, but perhaps a little more frequently on the neck and trunk than elsewhere. The cystic form is congenital, at least in its origin, being frequently found, and sometimes of large size, at birth, and is most frequently seen on the neck. The sacs in these cases may be simple or multilocular, and often closely resemble the congenital branchiogenic cysts, from which it may require the microscopic recognition of the epithelial lining to distinguish them. They sometimes attain a huge size, sometimes as large as the head of the individual.

While this disease, like the hæmatic angeioma, is one of very early life, Lesser has reported a case occurring in a man seventy-five years of age, although it then had more of the clinical appearances of elephantiasis. As has been said already, the tendency of pathologists is to admit elephantiasic changes under the head of lymphangeioma.

The *treatment* of the circumscribed tumors consists in extirpation. Ignipuncture has been successful in the diffuse form, either with the actual (Paquelin's) or the galvanic cautery. Probably electrolysis would be useful also.

Sarcoma.

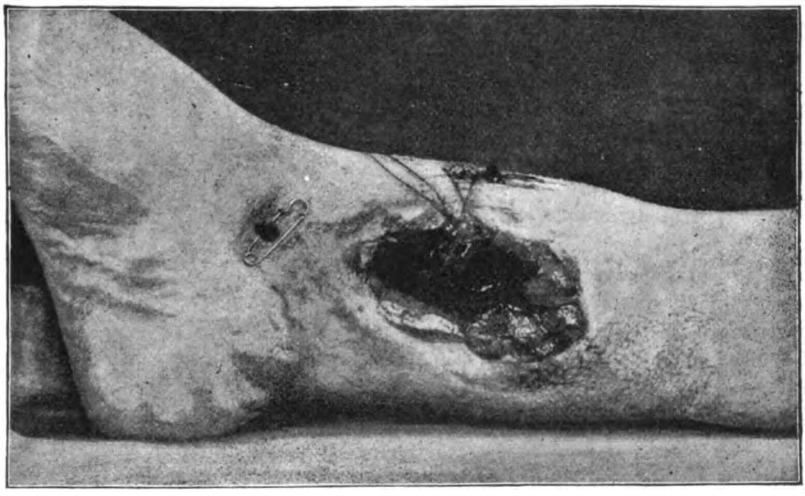
The many scattered facts about the sarcomata which require notice can best be studied by grouping them according to the tissues and organs affected by the new growth, and I shall adopt that plan, except that I shall begin with a special consideration of melanotic sarcoma, and shall close with an account of the treatment of these tumors by the inoculation of erysipelas.

Melanotic Sarcoma.—Among the rarer varieties of sarcoma, and one of the most malignant in its course, is the melanotic form. Dieterich has shown, however, that the prognosis after operation in these cases is not quite so hopeless as has been supposed. In a study based on 145 cases, taken chiefly from surgical literature, he finds that this form of neoplasm is rather more common in men than in women, and that it occurs at all ages, from six months to seventy-five years, but is most frequent from forty to sixty. The neck was attacked 11 times, the head 28, the trunk 41, and the extremities 48. The regional lymphatic glands were involved in 22 per cent. of the cases. The tumors had existed from four weeks to twenty years. In 13 cases without operation, the patients lived on an average fifteen months, while in 31 cases of operation with recurrence, the average duration of life was over three years. Of 114 patients operated on, 9 died, 33 were lost sight of, 37 had a recurrence in from two days to fifteen months, and 13 remained well, 6 for three years or more. All of the latter had had tumors extirpated from the soft parts—labium majus, thigh, ear, scalp, and groin.

The proportion of cures, therefore, was not much over seven per cent.

SARCOMA OF THE BONES.—Sarcoma of the bones is frequently called osteo-sarcoma, but this term should be dropped, because it signifies a tumor containing bony tissue, and this is not true of all sarcomata of the bones. In the study of these tumors it is important to distinguish between those of central and those of periosteal or subperiosteal origin. The former are rather less malignant, probably because they are quite frequently of the giant-celled variety, which has a slow course and very little tendency to invade the surrounding parts or to cause metastatic tumors. But round-cell and spindle-cell tumors also occur centrally, and do not appear to be less malignant than the subperiosteal tumors. The giant-cell variety can often be dealt with by a purely local opera-

Fig. 1598.



Sarcoma of Tibia which had been Mistaken for Osteomyelitis and Treated by Curetting. Girl, aged twenty. Disarticulation at knee-joint, August, 1892. In perfect health, February, 1894.

tion, and even if recurrence takes place, it is time enough then to treat the disease by amputation. Sarcoma of the bones is not infrequently *multiple*, as in the case reported by Coats, in which the sternum, ribs, humerus, femur, and nearly all the vertebræ were affected in the course of five years, or as in that of Nasse, who found tumors in the pelvic bones, ribs, vertebræ, tibia, and both femora, but could not decide which was the primary growth. While secondary deposits in the *ribs* are frequent, primary sarcoma is rare in these bones, and the cases reported by Brandl, Seydel, Humbert, Zarubin, and Mikulicz deserve notice. Brandl could find only five cases in surgical literature. In at least two cases the attempts at removal compelled the resection of portions of the diaphragm, but the patients recovered. Another rare situation is the *hyoid bone*, in which position Körner has recorded a case operated upon by von Bergmann, which occurred in a girl of eighteen, and which secondarily involved the œsophagus. A doubtful case treated by operation has also been reported by Le Dentu in a woman seventy-one years old.

In the way of *pathology*, Haberern has collected five cases showing that sarcoma may develop from the callus at the seat of a fracture. Berliner brings additional evidence to prove that the idea of Virchow, Hüter, and others, is incorrect, and that sarcoma of the bones is not limited in its advance by the epiphyseal line of the bone, but may cross this barrier.

The statement of Borck that not a single case was on record in which amputation at the hip had cured a case of sarcoma of the *femur*, has aroused interest in the subject of the results to be expected after operations for sarcoma of the bones. In regard to the hip, Borck himself quotes four cases in which the patients remained well for over two years after operation—one for twenty-seven months; one for thirty months, with "nodules" on the back and arms attached to the bones (hardly secondary tumors); one for three years; and one for thirteen years, with a suspicious tumor of the arm—the last two cases certainly deserve to be classed as cures. Rose relates a case in which he amputated at the hip joint in a woman twenty-four years of age, and at the same time excised a recurrent nodule in the scar of a breast removed three years before, and obtained a cure, for she lived seven years without recurrence, finally dying of gout. Küster reports a case which had been without recurrence for three years.

Gross, in a collection of 90 cases of sarcoma of the *long bones* observed sufficiently long after operation, found 26.6 per cent. of cures, the patient remaining well for three years or more. His tables show well the difference between the giant-cell and the other tumors, for in the former 40 per cent. of the patients remained well for three years or more, while of the latter only 17 per. cent. were cured. Nasse, in 39 cases from von Bergmann's clinic, corroborates Gross's figures, obtaining 22 per cent. of cures, and his results are more reliable than Gross's, since they represent the results of an uninterrupted series of cases at one clinic, while Gross selected his at random from the records of surgical literature. Coley reports from the New York Hospital 9 cases of round-cell and spindle-cell sarcoma, in which 3 patients died, 1 had a recurrence, 1 was lost sight of, and 4 remained well for two, three, eight, and nine years respectively. Chavasse, in a table of cases of removal of the scapula and arm for tumors affecting the former, found in 38 cases 9 deaths, 9 patients lost sight of, 13 recurrences, and 7 patients well (3 for eighteen months, 2 for two years, 1 for six years, and 1 for nine years).

SARCOMA OF THE NERVES.—Sarcoma arising from the nerves springs from the endoneurium, and authorities are divided upon the question as to the presence of an increase of nerve-fibres in the tumor, Krause claiming that he has found an increase, or at least a lengthening, of the primitive nerve fibres, which pursued a very tortuous course through the growth, while the majority of writers, including the recent contributors Garré and Goldmann, deny that this was present in their specimen. It is necessary to distinguish between the single tumors occurring upon previously healthy nerves, and the so-called malignant degeneration so common in multiple fibromata of the nerves. According to Krause, the single tumors occur especially on the main nerves of the extremities, particularly the median, in the arm and forearm, and the scia-

tic; but they are also found growing from minute nerve-fibres in the skin, although it is difficult in such cases to prove their connection with the nerve. He finds them present equally in both sexes, and at all ages from five to fifty years, although most frequent between twenty and thirty years. In many cases there is a family history of nerve-tumors, although not so often as in the multiple fibromata. The single tumors are either soft or hard, the softer forms being usually, though not invariably, the more malignant. Sometimes a tumor which has run a very slow course will begin to grow rapidly. The neoplasms are at first usually well encapsulated by the sheath of the nerve, and consequently are generally smooth on the surface, although they may be bossellated. They are hard or elastic to the touch. Subsequently they penetrate the capsule, invade the surrounding tissues, and may ulcerate. The lymph-glands, however, remain free, and metastasis is unusual. The first symptoms may be pain and loss of power, and tenderness in the course of the affected nerve. In extirpating these tumors it will usually be necessary to resect the entire portion of nerve involved, or to amputate, more restricted operations resulting in an early return. But McBurney has recorded a case occurring in the median nerve, in which he preserved some fibres, and in which the patient remained free from recurrence for at least two years. As to ultimate results there are not many reports. Hume has recorded three cases, in one of which the growth recurred, while in the other two the patients were well nine months and four years afterward.

The form of tumor which develops upon a multiple fibroma, or elephantiasis of the nerve, is remarkable in the complete series of intermediate forms which exist between the fibroma and sarcoma. Garré considers traumatism to be an undoubted factor in promoting the change. It is remarkable that at least one-eighth of all cases of multiple fibroma end in sarcomatous development. The sarcoma is usually of the spindle-cell variety. Clinically these cases present the combined picture of multiple fibroma of the nerves with a single malignant growth.

SARCOMA OF THE BREAST.—One of the organs more commonly affected with sarcoma is the *mammary gland*. Gross has collected and analyzed 156 cases, partly from his own experience, and Poulsen has studied 33 cases from the Copenhagen clinic. Schmidt moreover has made a special study of the so-called angeio-sarcomata or endothelial growths, occurring in this organ, based on 11 cases. Sarcoma is most common in the breast between forty and fifty years of age (one-third of the cases), and nearly as common in the preceding decade. It has been observed as early as nine, and as late as seventy-five years. About one-half of the cases are cystic growths, besides some which show cystic degeneration. The chief histological varieties are the spindle-cell, in 68 per cent. of the cases; the round-cell (including the rare endothelial tumors) in 27 per cent.; and the giant-cell in only 5 per cent. The spindle-cell tumors appear at an earlier period of life than the others, the difference averaging nearly twelve years—thirty-six as compared with forty-eight years of age. The cystic forms also appear earlier than the solid, being found at thirty-eight years of age as compared with forty-three. The cystic form is due to retention from closure

of the ducts of the gland, and may occur in any histological variety of growth; but it is important to distinguish between the cystic and solid tumors on account of certain clinical differences between them.

Sarcoma of the breast is a decidedly malignant form of tumor, although less rapid in its course, and less apt to attack the surrounding parts, than carcinoma. Of Poulsen's 33 cases, 4 had a duration before operation of one month, 15 from one to twelve months, 2 each for two and three years, 4 from five to eight years, 3 of ten years, 1 of seventeen years, and 2 actually of forty years. In cases with this very long history it is usual to find that the tumor has existed as a small, indolent, quiescent, or slowly increasing growth, for a long time, and that it has suddenly become more threatening, assuming a totally different character. In these cases, too, the tumors are generally found to be cystic, and the size is suddenly increased by rapid effusion, or by growth of solid contents; or the tumor may be found to be telangeiectatic, and perhaps the seat of hemorrhages. Gross approves the opinion advanced by some that in such cases the tumor has been originally a fibroma, the occurrence of sarcomatous change explaining the sudden increase in growth. In rapidly growing tumors he has noted an increased local temperature, as shown by the surface thermometer.

The evidences of local infection are much less marked than in carcinoma. The *nipple* is seldom retracted—in only 2 of Poulsen's cases, and in only 5 of Gross's—and the latter adds the statement that all of these were of the cystic variety. *Adhesion* to the surrounding parts is also comparatively rare, deep adhesions being found in only 7 cases of Gross's collection, and cutaneous adhesions in only 15. Poulsen, however, found adhesion to the skin in over one-third of his cases. *Ulceration* of the skin occurs seldom, and usually from pressure of large tumors causing local necrosis; Gross says that it occurs in about one-fifth of the cases. The *axillary glands* are sometimes enlarged, but seldom diseased. Poulsen, however, found them involved in 15 per cent. of his cases, decidedly more frequently than has generally been acknowledged.

Pain was present in more than one-third of the cases, but in less than three per cent. was felt before the tumor was noticed. A *discharge of blood or serum* took place from the nipple in about one-tenth of the cystic cases. Gross declares emphatically that *age* has no effect upon the malignity of the tumors, which are not more rapid in their course in the young than in the old. The prognosis, however, is influenced by the rate at which the tumors have grown before the operation. He finds that cystic tumors grow more rapidly, and are more likely to return and to have metastases, but Poulsen takes quite the opposite side of this question. Poulsen found that in 14 cases of the cystic form, operated upon, 75 per cent. of the patients remained well for five years or longer, including 2 who had a second operation for recurrence, and 1 from whom infected glands had been removed when the breast was excised. In 18 cases of operation for solid sarcomata, Poulsen found seven recurrences, and only 58 per cent. of the patients remained well for four years or more, including four on whom two operations were performed. This difference is explicable only on the supposition that the pathological views of the two authors differ. Gross found that in 91 cases operated on, the histories of which were subsequently traced,

there were 59 recurrences, while 32 patients remained well, but only 19 for three years or more, a proportion of cures of 20.8 per cent. The latest recurrence took place four years after operation.

The *endothelial sarcomata*, known also as *angeio-sarcomata* (a term which is misleading and should be avoided), and by many other names, probably should include most of the so-called *alveolar sarcomata.* Schmidt claims that these originate from the endothelial cells of the perivascular spaces, and rather unnecessarily suggests the name "perithelioma." He has studied 11 cases in the breast, partly patients under his own observation. In every instance the patient was over fifty years old, more than half of them were married, while in two cases there was evidence of traumatism, and in two a history of antecedent mastitis. Besides the advanced age of the patients, the tumors presented certain well-marked clinical features: all were seated near the periphery of the gland except one which was directly under the nipple, and two which involved the entire breast; all were single, from two to eighteen months in duration before operation, and varying in size from that of a hen's egg to that of a child's head; sometimes hard, sometimes soft; not adherent to the breast, but always adherent to the skin, though without the dimpling seen in carcinoma. The glands were frequently enlarged, but probably very seldom diseased. In spite of these benign characteristics, the tumors recur rapidly, and generally cause metastasis. Their cells often show hyaline degeneration.

SARCOMA OF THE GENITALS.—In the *uterus*, sarcoma is rather a rare form of malignant disease, although probably more common than has been supposed in the past. According to Gusserow the single tumors, usually fibro-sarcomatous, are less common than those of the diffuse variety, which attack the mucous membrane primarily. In either case the seat of the disease is usually in the body of the organ, although cases have been observed in the cervix, and the growths have then generally been polypoid in form. Of the first variety Gusserow found 32 cases, and probably some of the "recurrent fibroids" of the older writers belong here. The second variety often shows an overgrowth of the epithelial cells, and may properly be called a carcino-sarcoma. I have already, in speaking of rhabdo-myoma, mentioned certain tumors of the uterus, of which Pernice has collected seven cases, of a sarcomatous nature, containing striped muscle fibres, and noted for their tendency to return after removal and for their polypoid form; they are usually found connected with the cervix. Gusserow says that there are no known cases of cure of sarcoma of the uterus, although metastasis is rare, and life has been prolonged for as much as six years by surgical treatment. Other writers, however, are not so hopeless, and the fact that the tumors develop in the body of the uterus, although making their early recognition difficult, should give the surgeon time to make his diagnosis and remove the organ before dissemination has occurred.

Sarcoma of the *ovary* is not uncommon, but its life-history is rather obscure because, owing to the malignant appearances so often assumed by papillomata and proliferating cysts of that organ, those tumors have often been confounded with sarcomata. In six hundred cases of ovarian tumor operated on in Schroeder's clinic, Cohn found ten sarcomata, not

including one dermoid-sarcoma and three myxomata. In these ten cases three patients died from the operation (high mortality being a recognized characteristic of malignant tumors of the ovary), two had recurrences, and the remaining five continued well, one of these having been observed for four years after the operation. The prognosis therefore is not absolutely hopeless, although it is certainly very bad. In the *vagina* also sarcoma gives a very bad prognosis. It is not a common tumor, and Gow was only able to find thirteen cases, nearly all occurring in married women, chiefly between thirty and forty years of age; all but one of the tumors, which were usually single, were seated in the lowest third of the canal. Recurrence after removal was the rule almost without exception.

Fig. 1599.

Sarcoma of Ectopic Testicle.

Sarcoma of the *penis* is rare, and Fischer, who records a case of the melanotic form, was able to find only three others in surgical literature. I can add nothing to Mr. Butlin's excellent account of sarcoma of the *testicle*, but give an illustration (Fig. 1599) from a case in which the disease was developed in an undescended testis.

The patient, a man 22 years of age, says that in his eleventh year he received a kick in the scrotum which drove both testicles up into the groins, where they have remained ever since. The left testis lies in the inguinal canal and is healthy. A hernia exists behind it. For two or three years the other testis, in the right inguinal canal, has been enlarged, and for five months it has been growing more rapidly and has been painful. The patient denies any venereal history. The tumor is hard, not tender, and three or four times the size of the normal gland. The skin is not adherent, but the tumor is fixed in the canal. The testis was removed in February, 1894, by Dr. Robert F. Weir (to whom I am indebted for permission to publish the case), at the New York Hospital, and the clinical diagnosis of sarcoma of the testicle was confirmed microscopically.

SARCOMA OF THE BLADDER AND PROSTATE.—Although sarcoma of the *bladder* was previously supposed to be very rare, there can be no doubt that it is really quite common, for Fenwick has been able to collect fifty cases, and refers to nine specimens preserved in the London museums. Of the fifty cases, 34 per cent. were of round-cell tumors,

and 17 per cent. of spindle-cell, while in one case cartilage was present. The growths varied in size, the average being as large as a hen's egg, and the largest the size of two fists. One-fifth of them were covered with villous growths upon their surface. These tumors occurred either before five or after fifty years of age, the middle periods of life being free from them. In children they were often multiple, and tended to assume a polypoid form, while in adults the reverse was true. In children too they were seated in the lower portion of the bladder, while in adults the most common situation was low down on the posterior wall, near the ureters. Albarran, in a collection of ninety-seven cases of operation for malignant tumors of the bladder (both sarcoma and carcinoma), found only two in which the patients remained well for any length of time—for one year and for three years—the former an example of sarcoma, the latter of carcinoma.

Sarcoma of the *prostate* is also well known, although not a very common form of tumor. It would seem probable that many of the so-called carcinomatous tumors of the prostate occurring in children might be really sarcomata.

SARCOMA OF THE NOSE, MOUTH, TONSILS, JAWS, TONGUE, AND SALIVARY GLANDS.—Coming now to a general review of other situations where sarcoma is found, and beginning with the *nasal cavities*, we find here an unusual benignity of course, in that, according to Bosworth, among 38 cases 12 are supposed to have been cured. In this region the disease appears to remain localized, to run a slow course, seldom to infect the lymphatics, and to be amenable to small operations. In the *naso-pharynx* the disease is much more malignant, growing rapidly, recurring frequently, and infecting the glands early; yet cures have been reported, sometimes after many successive operations. In the *oro-pharynx* the same is true, and yet Bosworth was able to find among 17 patients 3 who remained well for two, five, and six years, showing that the prognosis is not absolutely bad. In the *soft palate* we come again to a region where the disease tends to remain localized, and the prognosis is fairly good, but this good prognosis in my opinion probably depends chiefly upon the fact that here we meet with many of those forms of tumor which, although known as sarcoma, are not really clinically malignant, such as the "mixed" or teratoid tumors, and the alveolar sarcomata of endothelial origin. Of 15 patients with sarcomata in this region, Bosworth classifies 6 as remaining well. Sarcoma of the *tonsil* has lately been exhaustively studied by Newman, who has collected fifty-six operations, some of them partial, after which there was no recurrence in one year in two cases, none in two years in four cases, and none in five years in two cases; but of the subjects of these local "cures" two died of sarcoma elsewhere, and one of the same growth in the other tonsil.

Sarcoma of the *upper jaw* deserves consideration here rather than under the head of sarcoma of the bones, owing to the complex nature of the structures involved. It is interesting to find, however, that in this situation the general rule already laid down of the comparative benignity of osteoid or giant-cell sarcoma holds true as well as in the long bones, for of 9 cases of this form of growth requiring six partial and three entire removals of the jaw, Küster obtained a cure in all,

while in 5 cases of round-cell and spindle-cell sarcoma, all treated by entire removal, two patients died from the operation and the disease in the others recurred. Czerny in 18 cases of sarcoma of the upper jaw, reported by Wassermann, lost 2 patients from the operation, and had recurrence in 9, while 6 remained well, 4 for three, five, eight, and nine years respectively, representing 2 round-cell, 1 spindle-cell, and 1 melanotic sarcoma. In his only case of sarcoma in the lower jaw, a giant-cell tumor, the patient was well nearly seven years after the operation.

Sarcoma of the *tongue* is quite a rarity, and during the last few years but few cases have been recorded. Scheier, in reporting a case, says that he could find in surgical literature only seventeen, of which he gives a table. Jacobi has reported a congenital case, and the rest range through all periods of life, the oldest patient being over sixty. In contrast to the rarity of women among sufferers with carcinoma of the tongue, is the fact that 6 of the 17 cases of sarcoma were in the female sex. The tumor differs from carcinoma, too, in its frequent occupation of the root of the organ, while it appears to occur very seldom upon the edges. It may be pedunculated. The mucous membrane is usually smooth on the surface of the tumor, and in only four of the recorded cases was it ulcerated. The lymphatics are infected late, and rarely. The growth of the tumors is sometimes rapid, sometimes exceedingly slow. All of the 17 cases were submitted to operation, recurrence taking place in 7, while 4 patients were lost sight of and the rest were cured. The recurrence took place two years after the operation in 2 cases, and only 4 patients were observed to remain well over that time, namely, for two, four, four, and six years respectively, but even this number furnishes over 30 per cent. of cures.

Sarcoma of the *salivary glands* is quite common, but it must be remembered that many, perhaps the majority of tumors in these organs are not clinically sarcomata, although held by some pathologists to belong to this variety of growth; these constitute the curious class of mixed tumors, which I shall consider by themselves. Their composite structure, slow growth, and the complete organization of the various tissues represented in them, distinguish them at once from the ordinary types of sarcoma. Endothelial sarcomata also occur in the salivary glands, and appear to be quite mild in their course. The typical sarcoma, however, in this situation is of rapid growth and almost invariable recurrence, perhaps because of the difficulty of complete removal without injuring important neighboring parts, and the consequent natural tendency to conservatism on the part of operators.

SARCOMA OF THE STOMACH, INTESTINE, AND SPLEEN.—Sarcoma of the *stomach* in the primary form is rare, but not so rare as text-books would lead one to suppose, for the numerous operators upon the stomach for tumors have of late years put on record several cases of sarcoma. The clinical and pathological history remains unwritten as yet, but this form of disease should be suspected when rather rapidly growing tumors are found in young subjects, causing few symptoms, for they appear to occur more frequently on the sides of the organ than at the pylorus, and hence do not cause obstruction. In the *small intestine* sarcoma is also rare, and Madelung in a recent study could find only eleven recorded cases to add to three of his own. The tumors in this situation

were frequently multiple, and metastasis was common, the duration of the symptoms varying from two weeks to eighteen months before death. They were particularly noteworthy in that they did not cause constriction of the bowel like carcinomata, but rather a pouchlike dilatation, whence the absence of intestinal obstruction and of distinct tumor, which was characteristic of so many. In four cases operations were performed, and two patients recovered, but no late reports exist as to the permanency of the cure. In the *large intestine* sarcoma appears to be even rarer than in the small.

The *spleen* is sometimes attacked with sarcoma, usually of the lymphoid type, and several such cases have been subjected to operation, successfully as far as immediate recovery is concerned; these were the cases of Flothmann, Asch, and Kocher.

SARCOMA OF THE KIDNEY.—The kidney is not infrequently attacked by sarcoma, especially in children, this being the most common form of malignant tumor at an early age. Formerly a hopeless condition, it would appear that at last surgeons are beginning to make some advance in its treatment. In 100 cases of nephrectomy for malignant tumors of the kidney collected by Barth, although the mortality was very high, reaching 42 per cent., 7 patients remained well for two years, 1 for three years, and 2 for four years. Israel has recently given a summary of his work in this direction, having had 2 deaths and 2 recurrences in 11 cases, the rest remaining well for less than one year in 4 cases, for over two in one, for four in one, and for five in one case, two cases of long duration having been examples of sarcoma. Abbe too has recently related two cases of nephrectomy for sarcoma in children respectively fourteen months and two years old, who remained well 1 year and 1½ years after the operation, both tumors having been very large. In one case a portion of the kidney was healthy, and was left, the tumor being separated from it.

I have already commented upon the occurrence of striped muscle fibres in kidney tumors, and similar cells are found in the sarcomata of that organ. Ribbert has collected seven such cases from surgical literature, and has added one of his own, in which the pelvis was distended by multiple polypoid growths of the structure referred to, so that the case was remarkable for the gross as well as for the microscopic appearances of the specimen.

SARCOMA OF SEROUS AND SYNOVIAL MEMBRANES AND TENDONS.—Sarcoma of the *serous membranes* is unusual, but cases have been reported by Lane of a general fibro-sarcomatous change of the *peritoneum*, and by Hofmokl of sarcoma of the *pleura* (mistaken for pyohæmothorax), in a three-year-old boy. Garré and Weir report cases of sarcoma of the *knee-joint capsule*, and Markoe and Weir of the *sheaths of the tendons*. Garré's case occurred in a tuberculous woman, and was mistaken for tuberculous arthritis, but was treated by amputation, in spite of which metastasis occurred and the woman died. It was thought that the tumor might have originated in the bone. In Weir's three cases the tumors were localized; in one the limb was amputated, and in two the growth excised, and in one of the latter the patient was known to be well several years afterward. In the tendon-sheaths the

disease appears to require amputation in order to secure permanent recovery; of five cases three were in the foot and two in the hand. The tendons themselves were not affected.

Tendons, however, although very rarely attacked by sarcoma, are not entirely exempt from the disease, as is shown by the case of Monprofit occurring in the flexor digitorum of the foot, and by that of Schulz in the corresponding tendon of the hand. In the latter case, the tendon lay exposed at the bottom of a traumatic ulcer, and it is probable that the disease was due to sarcomatous degeneration of granulation tissue.

SARCOMA OF THE SKIN.—Sarcoma of the skin usually occurs in the form of multiple small tumors, with very late metastasis, and sometimes runs a very long course. It has even been claimed that some tumors which had recurred after operation in these cases of multiple growth, had subsequently undergone spontaneous involution. It is well to bear this in mind in connection with the claim of Köbner and others that these cases can be cured by the internal administration of arsenic. We have seen that multiple fibromata of the skin sometimes disappear, and care must be taken not to confound these two similar forms of cutaneous lesion. The sarcomatous tumors are often pigmented, and are then usually more malignant. Besides this rather benign form, typical single sarcomata are found, very often supervening upon granulation tissue in some wound or ulcer. Here too the chance for error is considerable, as it is easy to confound ordinary granulation tissue with sarcoma. That some of these single tumors are markedly malignant in spite of their very small size, is well illustrated by a case in which I excised very freely a small sarcomatous cauliflower growth which had appeared without cause upon the skin of the shoulder of a young and healthy man. Some months afterward the axillary glands of that side enlarged and were thoroughly extirpated. Again, after a few months, the cervical glands enlarged, without any return at the original seat of disease or in the axilla, and while the patient was debating the question of a third operation, he died suddenly with cerebral symptoms that indicated the probability of internal metastasis. Sometimes these sarcomata of the skin attain a very large size, as in the case reported by Conner, which occurred upon the scalp of a young woman, and which, during fifteen years of slow growth and five months of rapid increase, attained a size of 17 by 15 inches, and 21 inches in circumference.

TREATMENT OF SARCOMA.

Wherever these tumors occur, the attempt has been made to cure them by operation, and I have already indicated with what measure of success. The proportion of cures in the different organs varies so widely that it is impossible to give any figures which are generally applicable, and I only repeat that in the bones there are about 25 per cent. of cures, and in the breast from 20 to 75 per cent. This is rather more satisfactory than the results in the epithelial malignant growths, but in many of the organs the results are much worse, yet they should encourage us to farther efforts, especially if the patients can be brought

to submit to earlier operation. For this form of malignant disease, however, we have another method of treatment which promises well, and that is the inoculation with erysipelas or its bacterial micro-organisms, or the injection of their sterilized cultures.

Following the experiments of Fehleisen after he had separated the streptococcus of erysipelas, in which he inoculated patients suffering from malignant disease with erysipelas by means of pure cultures of the germ; and in view of the cases collected by Bruns, of erysipelatous infection accidentally occurring in such patients and producing permanent cures; but especially stimulated by Bull, who had observed such a case in his own practice, Coley began making inoculations of pure cultures in advanced cases of malignant disease. Spronck had meanwhile been working on the same lines. Afterward, instead of inoculating the cultures, injections were made with the toxic products of these cultures, sterilized by heat or by other methods. Coley sums up the results of all the cases treated by these plans as follows: Carcinoma, 20 cases, 3 permanent cures; sarcoma, 19 cases, 8 permanently cured—the proportion of cures therefore being respectively 15 and 42 per cent. The patients who were not cured were many of them improved, their lives lengthened, and their sufferings diminished, for it is to be noted that the injections, although often themselves painful, appeared to lessen the pain of rapidly growing tumors. In the whole list of 39 cases there were 3 deaths, but only 1 from intentionally inoculated erysipelas, and the new method of using the toxic products appears to be practically free from danger to life. Taking by themselves the cases of inoculation in sarcoma, we find 8 cases with 3 cures, or over one-third, a result which is very remarkable when it is considered that the treatment has only been employed in hopelessly inoperable cases; it should be observed, however, that the results obtained by others are not so good as those claimed by Coley, to whose recent papers I must refer for the details of this method of treatment.

MIXED TUMORS.

In this class I would place those composite tumors of the parotid and other regions in which a large number of different tissues, both homologous and heterologous, are found. These tumors are very closely allied to the sarcomata, although in some specimens it is impossible to find any truly sarcomatous elements, and although the tumors are distinguished by their slow and benign course they should undoubtedly be considered as sarcomata from a pathological point of view. In these tumors are found fibrous, myxomatous, fatty, and cartilaginous tissues, each portion perfect in its structure, and all closely intermixed. Besides these benign portions there will be intermediate areas, containing cells in rows, tubes, and even alveoli, cells whose origin in some cases is clearly from the endothelium (lymph spaces, perivascular channels, even the endothelium of blood and lymph vessels), and in other cases is doubtful, while in some the tissue strongly resembles epithelium and is held by some authorities to be of this type. It would appear, however, that the view which considers all these cells as of endothelial origin agrees better with the undoubted connective-tissue origin of the rest of the

tumor. We should, therefore, consider these portions, no matter how distinct the alveoli may be, as endotheliomatous rather than adenomatous. Besides these various homologous tissues are others which are frankly sarcomatous, either of the round-cell or spindle-cell varieties. These curious tumors have recently been carefully studied by Nasse, and I must refer to his paper for details. While they are chiefly found in the parotid, they occur in the other salivary glands, and also in the tissues of the cheek, lip, tongue, and soft palate, and in the mucous membrane of the mouth. Zahn has recorded a chondro-rhabdomyosarcoma of the thyroid in a fœtus. The tumors are noted for their occurrence in early life—they are probably always of congenital origin although commonly first noticed about puberty—and also for their very slow growth in many instances. But sometimes they are distinctly sarcomatous, clinically as well as histologically, and after a period of quiescence will assume a rapid growth and invade the surrounding parts. Usually they are well encapsulated, and cause no symptoms until they attain a large size, which they seldom reach even if left untouched for a life-time.

Endothelioma.

There are three sources from which endotheliomata may spring: from the lining of blood-vessels or lymph-vessels (such tumors being often known as angeio-sarcomata), from the lining of lymph spaces in the cellular tissue, and from free serous surfaces in cavities. The last-mentioned form is most common in the pleura, and next in connection with the serous surfaces about the brain. The tumors which form in the *skin* are, according to Braun, of two forms: mushroom-like in shape, with a smooth surface; or flat and prone to ulceration. In either case they spring from the vessels. The first form is not difficult to recognize by its peculiar shape and firm consistency, while the latter closely resembles rodent ulcer in its appearance and clinical history. But it does not occur so frequently at muco-cutaneous junctions as does epithelioma, it grows very slowly and with less tendency to infiltrate the neighboring tissue than that affection, and it probably never infects the lymphatic glands. Microscopically, it is common to see the endothelial cells of the tumor lying close to the epithelial cells of the skin, without any tendency to invade them or alter them in any way. Hyaline degeneration is frequent, and then the tumor has often been known as *cylindroma*. Snamenski describes two peculiar tumors of the *parotid* occurring in women 40 and 76 years of age, of two and eight years' growth respectively, which were removed and showed a structure of alveoli filled with flat cells resembling epithelium, but probably of endothelial origin, as there was a blood-vessel without proper walls in the centre of each alveolus, and in many comparatively healthy blood-vessels in the neighborhood the endothelium was thickened. These tumors would be called by some angeio-sarcomata.

Metastasis appears to be common in endothelioma of the *pleura*. Endotheliomata have been observed most frequently in the *testicle*, in the *ovary*, and in the form of *psammoma* met with in the *optic nerve*. I have already described their peculiarities in the *mamma*. Their rela-

tions with sarcoma and carcinoma have been much disputed. If the later theories in development are accepted, which derive the endothelium from the epithelial layer of the ovum, the connection between sarcoma and carcinoma is very close, and these tumors will form a connecting link between them morphologically as well as in histological appearances.

ADENOMA.

This vaguely defined group of tumors stands between normal gland structures and the carcinomata. Some would include in this class all tumors with increase of the epithelial elements of any organ, whether there be production of other tissues or not, and whether the result be a solid tumor, or a cyst, or a number of cysts. The tumors seldom exactly reduplicate the gland from which they spring, although they imitate it nearly enough, as a rule, to enable one to identify the organ from which the neoplasm has come by the structure of the growth.

In the *stomach and intestine* the adenomata bear a particularly close resemblance to the carcinomata, as they infiltrate the surrounding parts and cause metastases, and actual change of the tumor into carcinoma is very frequently seen. In the *rectum* the only means of distinguishing between the benign and malignant growths appears to be the fact that the former become polypoid, while the latter, although without a trace of carcinomatous structure, grow beneath the mucous membrane, infiltrate it in all directions, and return when removed.

Certain adenomata of the *thyroid gland* appear to have the power of producing metastases also, as in the cases reported by Morris, Cohnheim, Runge, and Coats. The secondary tumors occurred in the bones, especially those of the skull, and were observed to pulsate. In structure they exactly reproduced the primary growths, but showed no tendency to invade the surrounding parts, and remained encapsulated.

CARCINOMA.

In the study of carcinoma I shall follow the same plan as that adopted in the case of sarcoma, classifying the facts to be considered, and especially the chances for radical cure, under the different parts affected, and shall conclude with some general remarks upon the treatment of the disease and its results. I shall begin with malignant disease of the skin, most frequently occurring in the form of flat-cell epithelioma.

EPITHELIOMA OF THE SKIN.—A special study of the *calcifying epitheliomata* has been made by von Noorden. These tumors are enclosed in strong sacs, grow under the skin, nearly always on the head (fourteen cases on the head against three on the arm and two on the back), and run a very slow, benign course, resembling very closely that of sebaceous cysts. In fact, it appears probable that they originate in the sebaceous glands as adenomata, subsequently developing into epitheliomata. They have an alveolar structure, and the calcification, which is a degenerative change, takes place both in the epithelial cells, usually at the centres of the alveoli, and in the connective tissue of the

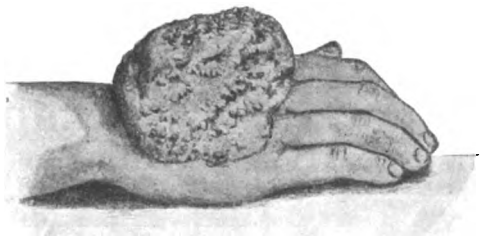
stroma. These tumors are usually found in adult life and in females—thirteen in women to three in men.

According to Gurlt's statistics, of 1377 cases of epithelioma nearly seventy per cent. occurred on the face. The next most frequent situations were the female genitals, only seven per cent.; the tongue, less than six per cent.; the jaws, four per cent.; and the male genitals, three and six-tenths per cent. The epitheliomata formed 40.23 per cent. of the epithelial malignant growths.

Carcinoma of the *face*, excluding only that of the lips, occurs from twenty years upward; indeed, Williams mentions one case of rodent ulcer in a girl at fourteen years of age. The proportion of males to females is about three to two. In the superficial form of epithelioma, known as rodent ulcer, the disease sometimes runs a very slow course, even twenty-five or thirty years in duration. Bonde, from a study of one hundred and twelve cases, gives the most common location of the disease as the nose, thirty-six per cent., twenty-eight per cent. occurring on the cheek, and eleven per cent. on the eyelids; while Williams, in twenty-six cases of rodent ulcer alone, found the neoplasm situated on the nose in seventy-three per cent., there being only two cases each on the cheek and eyelid, and one each on the forehead, temple, and upper lip.

Epithelioma of the *extremities* is among the rarer forms of malignant disease, and it is only recently that any attempt has been made to study its well-marked characteristics. Of all epitheliomata of the skin, those on the extremities are as a rule the most benign, and yet some of them are very malignant. Volkmann, who first systematically studied these cases, divided them into three classes: (1) Those which originated from irritation of some sort, such as ulcers, fistulæ, local skin lesions; (2) those which originated from warts, nævi, etc., subdividing these again into two varieties, according as the wart or nævus was of congenital origin, or appeared later in life; and (3) those arising from apparently healthy skin without known cause. Those of the first class are the least malignant of cancerous growths, spreading very slowly, infecting the glands very late, and not tending to return when thoroughly removed. They may originate from scars, ulcers of the leg, callosities, corns, subungual suppurating surfaces, chronic eczema, setons, lupus, and bone fistulæ. Only two cases of internal metastasis were found in the more than ninety cases of this kind which Volkmann collected. He suggests that the slow infection of the lymphatics may be due to the common cicatricial alteration and slight vascularity of the surrounding tissues, contrasting it with the rapid infection which takes place in opposite conditions around tumors accompanied by inflammatory reaction and congestion, as seen in tumors near the mouth, penis, and groin.

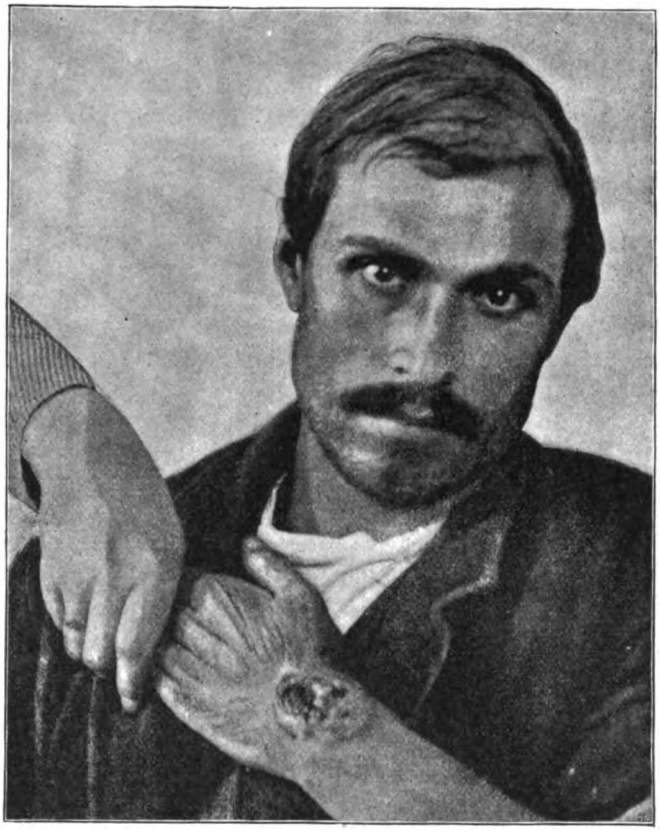
Fig. 1600.



Epithelioma of Hand in a Man Forty-nine Years of Age. Tumor had grown slowly for six years and then increased rapidly for three months. Motion of fingers not affected. (From a photograph.)

Those cases which originate in congenital warts and nævi are, on the other hand, among the most difficult of cancers to treat successfully; indeed, of the eleven cases collected by Volkmann, in every one there was recurrence after operation, and death ensued within eighteen months of the first appearance of the tumor. Michael has since reported a case from the Tübingen clinic, however, in which the patient remained well, having been kept under observation for nearly four years. Rapid glandular infection is commonly seen in these cases. When the warts are of later appearance the prognosis is much better, nearly one-half of such cases being known to have ended in cure.

Fig. 1601.



Epithelioma of Hand developed in Cicatrix of Burn received in Childhood. Patient, an Italian, twenty-five years of age.

The cases of the third class, developing from healthy skin, of which one-half were situated on the back of the hand, also have a fair prognosis.

Michael adds to Volkmann's cases those which occurred in the Tübingen clinic, as well as Schneider's, from Von Bergmann's clinic, reaching thus a total of two hundred and sixty-three cases, of which only seventy-eight occurred in women; the ages of the patients varied from twenty to ninety years, but one-third were between fifty and sixty years. Thirty-five per cent. of the cases occurred on the leg and twenty-four per cent. on the dorsum of the hand. The upper and lower extremity were affected in the relative proportion of about two to three. The rarest situation was the palm of the hand, only three cases being known in that position, which is in curious contrast to the frequency with which the dorsum is attacked, as well as the sole of the foot, the disease having been observed nineteen times in the latter locality. I append two illustrations of epithelioma of the dorsum of the hand. Fig. 1600 shows the fungating form. Fig. 1601 represents an instance of very early development.

Extensive epithelioma of the skin, occurring either as a single tumor

or as multiple small tumors of the cutaneous covering of the *chest*, the true cancer *en cuirasse*, has been occasionally observed, and lately cases have been reported in this country by Duhn and Hyde. The former saw the disease in a man forty-nine years of age, the new growth having at the time lasted seven months without ulceration, beginning near the nipple, and forming a patch on the right side of the body measuring six by twelve inches. This peculiar disease must not be mistaken for the much more common diffuse lenticular infection of the skin seen in cases of carcinoma of the breast, in which the nodules may form a single patch by coalescence, or may be scattered over the skin in lenticular tumors, and in which ulceration is usual.

Czerny adds one more case to the rare instances of true epithelioma of the *mamma*, meaning thereby a deeper form of epithelioma than that known as Paget's disease of the nipple. His case was in a woman fifty-three years old, who had an ulcer of the areola of ten months' duration, the nipple being retracted. The breast was removed and found to be healthy, although the supraclavicular glands were involved. Poirier has collected four cases of epithelioma of the breast (or of the skin over it) in the male. One case was cystic, and one subsequently became carcinomatous. In all, the course was more benign than in ordinary carcinoma.

Melanotic epithelioma is a rare form of disease, its very existence being denied by excellent authorities. It usually if not always begins in a congenital pigmented nævus, or mole. These patches in the skin are characterized by the presence of pigment, which may exist in all the layers of the skin or may be confined to any one, either rete or corium remaining uncolored, but even more characteristic is the rich cellular stroma which renders them more liable to sarcomatous than to carcinomatous degeneration. Epithelioma is very unusual; but a few well authenticated cases of melanotic epithelioma are on record, the most recent being those of Bowlby and Solly,[1] occurring on the great toe and on the vulva. The subject has also been discussed by Haeckel.[2] The case illustrated by Fig. 1602 is, according to Dr. John S. Thacher and other well-known pathologists of New York, one of these rare melanotic epitheliomata.

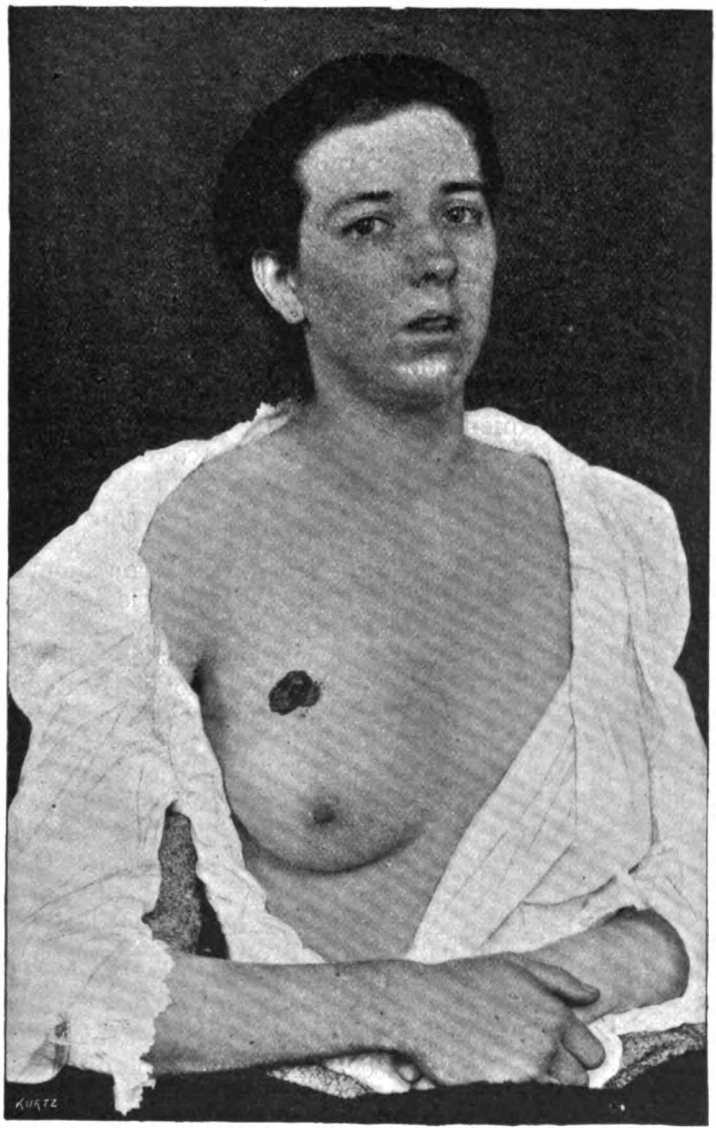
The patient, 27 years of age, of Irish birth, had a small congenital mole on the skin of the breast, like many others scattered over the body. About three months before she was seen by me this mole began to increase, and attained the size shown in the photograph, for which I am indebted to Dr. Robert Abbe, in whose care the patient came subsequently, and by whom she was operated upon. The tumor was flat, consisting merely of the skin increased to three or four times its natural thickness, and was of a black color like graphite (exactly like that shown in the plate of *carcinoma melanodes* in Hebra's "Atlas der Hautkrankheiten"), with an uneven warty surface, not ulcerated, not adherent to the subcutaneous tissues, rather soft to the touch, and presenting a few fine hairs. A few minute melanotic spots were disseminated in the skin just beyond the edge of the growth. The microscopic examination showed an epitheliomatous structure, with alveoli full of pigmented epithelial cells, which had evidently originated from the deep epithelial cells of the skin, although no cell-nests of flat epithelium were discovered.

The *results of treatment* of carcinoma of the skin, which, as we have seen, is almost exclusively epithelioma, are very good in the face, and

[1] Trans. Path. Soc., London, 1891, vol. xli., pp. 314, 315.
[2] Archiv f. Gynäkologie, Bd. xxxxii., Heft 3.

still better on the extremities. Thus Ohren found that of thirty-seven patients whose subsequent histories were known, nine remained well four years or more, that is, twenty-four per cent. Bonde reports even better results, having sixty-eight per cent. cured. In his cases, tumors

Fig. 1602.



Melanotic Epithelioma of Mamma.

situated on the forehead gave the worst prognosis. In the extremities, Volkmann in his statistical study found 38.6 per cent. of cures. Michael in twelve cases had nine cures, and combining the two sets of cases we obtain 43 per cent. of permanent recoveries.

CARCINOMA OF THE LIPS.—Williams found that of 352 neoplasms of the lip only 12 affected the upper, and of 332 epitheliomata only 3 were so situated. Of 33 cases from the Middlesex Hospital only 2 were in the upper lip, and both of these occurred in women. The lips are much more frequently the seat of cancer in the male than in the female, Williams finding, in his 329 cases in the lower lip, only 3 in women. The proportion, however, appears to be somewhat different on the Continent, for Wörner and Rapok, collecting respectively 866 and 919 cases from various German authorities, found that over nine per cent. occurred in women. While cancer in the lower lip is so much rarer in woman than in man, that of the upper is proportionately much more common, Eschweiler finding that, in sixty-one cases of epithelioma of the upper lip, twenty-four, or about two-fifths, were in the female sex. He estimates that in men there is one case in the upper lip to twenty-four in the lower, while in women there is one in the upper to every three in the lower. But it appears to me that Wörner's statistics, which make the proportions in men one on the upper lip to forty-five on the lower, and in women one to seven, are nearer the truth. Cancer of the upper lip appears to be more frequent in Germany than in England, for against Williams's 3 cases in 332, we must set Rapok's collection of 43 in 769, or in England less than one per cent., against five and one-half per cent. in Germany. The frequency of malignant disease in the lips, taken together, is, however, nearly alike in the two countries, for Williams makes cancer of the lip 4.5 per cent. of all cancers, while Virchow places it at 4.9 per cent.

Eschweiler says that the disease is less rapid in the upper than in the lower lip, often resembling the more superficial forms of epithelioma, and that recurrence is less apt to take place after operation. We must distinguish between epithelioma of the skin developing on the lip, and epithelioma involving the vermilion border or mucous membrane. Fig. 1603 represents an example of the former condition, which has a much less malignant course than the other, growing slowly and being less apt to recur after removal. Williams gives an interesting comparison between seven cases in which the disease in the lower lip ran its course without operation, the patients dying in an average of sixteen months from its beginning, and twelve cases operated upon and the disease recurring (including one in which the operation was fatal), the average survival being fifty months. As we shall see, the results of radical operations are even better than these figures.

Fig. 1603.

Epithelioma of Skin of Lower Lip, Vermilion Border Remaining Intact. Patient, thirty-six years of age; tumor of two and a half years' duration.

As to the exact situation of the disease in the lower lip, adding to 285 cases of Wörner the 59 cases of Williams, we find that of 344 cases it was on the right half of the lip in 89, on the left half in 80, in the middle in 85, and at the angle of the mouth in 24, while it involved the entire lip in 66; moreover, of fifty cases in which that point

was noted, there was more than one focus in five, although even in these it had begun in one spot.

Smoking has always been looked upon as a prime cause of cancer of the lip, but while Williams found among twenty-six patients sixteen extreme smokers and eight moderate smokers, with only two who did not smoke at all, and Wörner found fifty-one pipe-smokers in sixty-nine, on the other hand Rapok found tobacco used in only twenty-five out of fifty-four cases. Partsch and Wörner indorse Thiersch's theory that exposure to weather is one of the commonest causes of the disease, and Partsch found that of his ninety-eight patients seventy-three per cent. belonged to a class in life so exposed, while all of Wörner's patients were of the lower class engaged in agricultural occupations.

Glandular involvement takes place tolerably early, Partsch finding it present in one-half of his cases; but metastasis is not very common, for in ten autopsies Williams saw it only twice.

The results of radical operations for carcinoma of the lip are among the best. Czerny in fifty-six cases, of which twenty-two were under the three-year limit, found thirteen patients in the remaining thirty-four who remained well for three years, or thirty-eight per cent. Maiweg, of Bonn, claims 81 cures in 138 cases, or fifty-eight per cent., 32 of these cases having been observed for from three to six years, and forty-nine over six years. Wörner reports from the Tübingen clinic the results of 277 cases treated by operation, many of them before these operations were made as radical as at present, with the result of 106 patients remaining without recurrence three years or more, this number being 38 per cent. of the whole, or, if we deduct from the total 54 cases not observed as long as three years, the number free from recurrence will amount to 47.5 per cent. If the 16 cases in which the patients died from the operation are also deducted, this percentage will rise to 51.2. Of these 106 cases 37 had been observed for from four to ten years, and 11 for over ten years, without relapse. Collecting the cases reported in the clinics of Thiersch, Bergmann, Billroth, Winiwärter, Fischer, and Koch, and those reported by Partsch, and adding them to his own, making a total of 866 cases, Wörner found that 242 patients had remained well over three years, or twenty-eight per cent. of the gross number, without any deductions.

Carcinoma of the Mouth, Nose, Pharynx, Palate, and Tonsil.— The most usual situations for carcinoma of the *mouth* are in the cheeks, where it often appears to be directly due to ulceration set up by rough teeth, and in the floor of the mouth. In both situations the disease is generally epitheliomatous, but in the former it spreads quickly and is a very rapidly fatal form of the disease. It may run a very slow course in the floor of the mouth, but is apt to return after removal, probably because the latter has not been sufficiently extensive. In these cases very free excision must be resorted to, even removing everything down to the skin, watching for recurrence and then cutting still more widely, and if necessary removing a part of either jaw. Even in such cases a cure may be obtained.

Carcinoma of the *nasal cavities* is quite rare, Bosworth having been able to find only twenty-nine cases. In only two was there metastasis, and glandular involvement was unusual. The results of operation here

have been very unfavorable, not a single case of cure being on record; this is doubtless owing to the too limited scope of removal, in a region where, on account of its complicated form, free excision is especially needful.

Kronacher reports a case of primary epithelioma of the *hard palate*, where the disease is a great rarity, originating in an alveolar abscess of long standing. Carcinoma of the *soft palate* is also not common, Bosworth finding 20 cases, all but one in males, and one occurring in a child only four and a half years old (Berg). Gross saw the disease follow a papilloma; Brissaud saw it preceded by leukoplakia. Busachi reports a case of adeno-carcinoma (a rare form here), the size of a child's fist, which was removed successfully from the soft palate of a woman 49 years of age, and which he supposes to have originated from the palatal mucous glands. The disease seldom spreads to surrounding parts, although it is prone to return after removal, and the prognosis cannot be said to be very good. A better result might probably be obtained by very free removal of the neighboring tissues. The lymphatic glands are frequently affected.

Carcinoma of the *pharynx*, according to Bosworth, seldom extends from the naso-pharynx downward, or *vice versa*, and is more common in the lower portion. It is very fatal, invading the glands early, often making a very large glandular tumor while the primary ulcer is so minute as to escape observation. Death occurs early, and this is probably the reason why metastasis is not common. The disease usually attacks the lateral walls, but Laquer, and Edgren and Quenset, have lately reported cases where the posterior wall was attacked; in one case the disease had not recurred nine months after operation.

Carcinoma of the *tonsil* is not so rare as is generally supposed, and of the regions we are considering, with the sole exception of the mouth, the tonsil is the most frequent seat of the disease. Carcinoma of the tonsil is even more common than sarcoma, a fact which Bosworth explains by supposing it to be due to the usually late period of life at which tumors of the tonsil appear, a period when its lymphoid tissue has chiefly atrophied, leaving the epithelial element in the preponderance. Bryant, however, reports a case occurring at the age of 17 years. Glandular involvement is the rule, although metastasis is rare. As the disease progresses, pain is marked; ulceration takes place early, and may lead to fatal hemorrhage. Death follows rapidly, usually within a year after the discovery of the tumor. In 118 cases Bosworth could find only one of cure by operation, that of Mikulicz, in which the patient was alive and well two and a half years subsequently.

The results of treatment in cancer of these regions are poor enough, and, owing to the concealed position of the growths, and the difficulty of properly attacking them without extensive preliminary operations, such as pharyngotomy, resection of the jaws, etc., surgeons and patients are too apt to be content with limited removals, which are only palliative. The good results, however, recently obtained by Mikulicz, Iversen, Caselli, Kocher, and others, who have resected large portions of the pharynx while attacking carcinomata of the larynx, of the base of the tongue, etc., show that with equal boldness the operative results might be improved and cures obtained even here. The surgeon must bear in mind that it is not the size of the malignant growth, but its

inherent power for mischief, which should determine the extent of the excision, and that if a cure can be obtained it is well worth while for the patient to sacrifice a portion of either jaw, or to submit to such an extensive operation as pharyngotomy, even if the tumor to be removed be no larger than a pea.

CARCINOMA OF THE TONGUE.—Although histologically an epithelioma, one of the most intractable forms of cancer is that of the tongue, probably because of the constant movement of the organ, its liability to injury, and the great tendency of the parts in the mouth to sepsis. The general health is very soon affected, and the lymphatic channels are usually invaded early; in fact, Sachs cites instances in which they were involved as early as five weeks after the disease was noticed, although in some chronic cases the glands may escape for a long time. Often none can be felt until the skin is incised. In fifty-two cases Sachs found the submaxillary glands involved in forty-five, and in thirty-six they were the only glands attacked, while five times the infection skipped them and appeared in the cervical, submental, or retromaxillary glands. Bilateral involvement of the lymphatics is often found when the tumor itself is confined to one side..

Of 776 cases of carcinoma of the tongue collected by Pennell, Williams, Landau, and Sachs, 120 (fifteen per cent.) occurred in women, a proportion larger than is usually admitted. The ages of the patients affected varied from twenty years upward, and besides the one patient who was twenty years of age, there was one of twenty-three, and a third of twenty-five.

Of 303 patients who were questioned on these points (Williams, Whitehead, Pennell), sixty per cent. used tobacco, and the majority smoked a pipe; and nineteen per cent. had had syphilis.

Other local causes were direct injury in eleven cases, ulcers from bad teeth in thirty-seven, ichthyosis in fourteen, localized syphilis in fourteen, and glossitis in three—a total of 79 cases out of 194, or forty per cent. of the cases noted with this in view. It would therefore appear probable that in this form of cancer, as in epithelioma of the skin, local irritation played a very important part in the etiology of the disease.

As to the location of the tumor in the tongue, its most frequent situation is on the edge and at the anterior part; but by no means always anteriorly, for among forty-three cases situated on the edges Williams found twenty-one in the middle of the tongue, four in its anterior portion, and no less than fourteen toward the base. Adding together Williams's and Sachs's cases, we find in a total of 119, eighty-six on the sides, eight on the tip, seven on the frænum, six on the dorsum, five on the under surface, two involving the entire organ, two situated in its substance, and two occupying its posterior half, while only one occupied the anterior half. It is evident from this that the disease is almost invariably unilateral, at least at its beginning. When the new growth spreads beyond the tongue, which we learn from Sachs occurs in about thirty-eight per cent. of the cases, it most frequently involves the floor of the mouth and the gums, and next frequently the pillars of the fauces, while the tonsil is least often attacked—only twice in sixty-six cases.

In a recent paper I have analyzed several valuable reports upon the

ultimate results of operations for cancer of the tongue, which have been published during the last few years, covering 473 cases, with a mortality of 54 or 11.4 per cent. From those reports which are so particularized as to give the exact kind of operation performed, it is found that the entire tongue was removed in 139 cases with a mortality of 15.8 per cent., and that removal of one-half or less of the tongue was accomplished in 81 cases without a single death. The removal of the tongue through the mouth, with no preliminary operation except ligature of the linguals, was performed 163 times with a mortality of 12.8 per cent.; and 77 times the organ was extirpated by Kocher's method, or after resection or division of the lower jaw, with a mortality of 14.1 per cent. This slight difference in mortality should be noted, for it is contrary to the generally accepted opinion that the so-called simpler method of excision with scissors is much less dangerous than other methods. A fair estimate of the comparative risks of these operations may be formed from Kocher's cases recently published.

From 1872 to 1882 this surgeon operated 29 times with five deaths, and from 1883 to 1888 29 times with only one death, showing what practice will do in improving *technique*, and very likely also what experience can effect by selecting cases. He removed the tongue through the mouth, without preliminary operation except ligature of the linguals, in 18 cases without a death; but when Kocher selects this method of operating, it is because the case is unusually favorable. He operated by his own method in 12 cases with one death (8.3 per cent.), and by division of the jaw, or, in cases requiring it, by partial resection of the jaw, in 22 cases with four deaths (18.1 per cent.). The cases of the last group were very severe, for Kocher seldom operates by division of the jaw unless the disease is so extensive as to require partial removal of the bone, and such cases are obviously very unfavorable. These figures give, it seems to me, a true view of the choice of methods and of the results to be expected from each.

Now as to final results, which are known in 186 cases, recurrence took place in 111. Of those without recurrence, 51 were observed for less than three years, 8 for three years, and 16 for four years or more. Adding to these 186 cases the 54 deaths, we have a total of 240 cases with 24 cures at the three-year limit, or 10 per cent., and at the four-year limit 16 cases, or 6.6 per cent. If we deduct from the total the fatal cases, these figures become 13 and 8.6 per cent. respectively.

There were two recurrences among Kocher's cases, at 10 and 12 years after the first operation. Among his operations are included many very severe ones, and Sachs, in studying the effect of this point upon the final result, finds that in 18 cases living one year after the operation it had been severe in 7, of 13 cases living two years it had been severe in 5, in 8 living four years it had been severe in 4, and in 5 living seven years it had been severe in 3. Wölfler had claimed that recurrence took place more tardily in those cases in which the operation had been extensive, but Kocher's statistics show that in eight such cases recurrence took place in 5.1 months, while in 14 cases of excision limited to the tongue itself recurrence followed in 8.3 months, which seems more probable, for extensive operations imply extensive disease difficult to eradicate completely. Yet from the figures just given, Kocher appears to have been so successful that more than one-half of his long-

lived cases had been subjected to severe operations. Of all the cases which remained free for one year or more, ten in number, there were severe bone operations in three, glands were removed in five, and in only seven was the tongue removed through the mouth.

By way of comparison I quote Whitehead's statistics, which are also excellent in their way. He reports 17 patients surviving less than 3 years, 2 for 3 years, 5 from 4 to 10, and one over 10 years—25 out of a total of 129, the majority of the rest having been lost sight of.

CARCINOMA OF THE LARYNX.—In the treatment of cancer of the larynx, we have one of the battle-grounds between the specialist and the general surgeon. The statistics so far are rather against the latter, but they really prove little except that cases are subjected to radical operation too late, and, as in the case of the uterus, early diagnosis and prompt operation are quite likely to alter the figures at any time.

I have collected 73 cases with 22 deaths, almost exactly 30 per cent. In 27 total laryngectomies the mortality was 40.7 per cent., and in 37 partial laryngectomies the mortality was 21.6 per cent. But we must not jump at once to the conclusion that this is a true picture of the relative dangers of the two procedures, for it is to be remembered that the complete operations embrace most of the older ones, while the partial operations belong to more recent times and benefit by an improved *technique*. Strangely enough, in Kocher's ten cases he lost only one of six total extirpations, and two of four partial ones. In any case the mortality is something tremendous, but it is one which can certainly be reduced, as is shown by Kocher's good results, which are especially encouraging in view of the extensive character of his operations. The subsequent history of 22 cases of total extirpation has been noted, the disease recurring in 8 during the first year, in 4 during the second, in 1 during the third, and in 1 (Hahn's famous case) after nine years of health; in the remainder, the patients were free from recurrence—5 for a few months, 2 for two years, and 1 for more than four years. Of the cases of partial laryngectomy 29 were observed subsequently; in 13 there was recurrence in the first year, in 5 in the second, and in 1 after three years; while in those free from recurrence it was known that 6 patients were healthy for a few months, 1 for one year, 2 for two years, and 1 for three years. In each set 3 patients remained well over two years. Of the subjects of the complete operations, excluding Hahn's case, we have 13.6 per cent. remaining well over two years, and in the subjects of the partial operations 10.3 per cent. Both sets of figures combined give 11.7 per cent. But if we apply the usual three-year limit, we find only three patients cured, even including Hahn's, or 5.8 per cent., the worst result of all operations for cancer except in the internal organs. But then the operation has not yet had fair treatment, and this is evident from the fact that recurrence is so frequent, although it is well known that the glands are very late in becoming involved in this form of cancer. I believe that the ultimate results here should certainly equal those obtained in excision of the tongue, and that the mortality ought not to be much higher.

CARCINOMA OF THE THYROID GLAND.—This most hopeless form of carcinoma has recently been studied by Braun, Orcel, and Hinterstois-

ser. Seventy-five per cent. of the cases develop in glands which are already goitrous. The tumors grow rapidly, frequently cause metastasis, and bring death as a rule within six months. Operations appear to be useless, for in 34 cases 22 patients died soon after from various causes, and the remaining 12 lived only from two to sixteen months, recurrence taking place almost invariably. Epithelioma is occasionally found in the thyroid gland, as in the case reported by Busachi, in a man only 18 years of age who died of a tumor the size of a man's fist, broken down in the centre, with some spots of calcification in the stroma. No primary tumor elsewhere could be found, and Busachi thinks that the growth may have originated from some branchiogenic remains. Billroth reports two cases of scirrhus of the thyroid, the structure exactly resembling that of scirrhus of the breast; in one case the disease was very rapidly fatal.

CARCINOMA OF THE ŒSOPHAGUS.—Primary disease of the œsophagus usually occurs in males, and in the lowest third of the canal. The statistics of gastrostomy for the obstruction caused by cancer of the gullet are much better than formerly, and yet, when patients are able to take care of themselves intelligently, it cannot be denied that treatment by permanent tubage will probably prolong life equally well.

CARCINOMA OF THE STOMACH AND INTESTINE.—There is not much new to chronicle in regard to carcinoma of the stomach and intestine. Hauser has shown by serial sections of these tumors (similar to those made by the embryologists in their work) that there are no closed alveoli, all of these spaces being simply sections of convoluted and branching tubes of epithelium, connected with the original glands of the mucous membranes. This observation gives further support to the doctrine of the exclusively epithelial origin of the neoplastic cells. There are many cases now on record of operation for the radical cure of carcinoma of the stomach and intestine, and most noteworthy are the series of Billroth, Czerny, and Kocher; but instances of long freedom from return remain rarities, although the mortality of the operation is steadily decreasing in practised hands. Kocher reports his nine last cases of resection of the pylorus with only two deaths. Czerny is inclined to be despondent as to the success of our efforts for radical cure, and says that such cases will probably always remain rare surgical feats, and that the best that the surgeon can do will be to overcome the obstruction which the tumor causes in the gastro-intestinal tract by some form of anastomosis of the canal above and below. Kocher is more hopeful, and quotes the cases of Wölfler, Billroth, and Rydygier, in which life was prolonged for two and for five years after resection of the pylorus, adding two cases of his own, in one of which the patient died in three years of a stenosis which proved to be simply cicatricial, while the other patient continued in perfectly good health five years after the operation. In the intestine, also, isolated instances of a cure as estimated by the three-year limit are known.

The insuperable obstacle to successful treatment of these cases is the impossibility of recognizing the disease before its extent precludes all hope of cure. Yet if by chance such tumors should be discovered in the early stage, there is no reason why they should not be cured by

radical operations, and perhaps we may yet be able to make our diagnosis earlier than at present. The attempt should certainly be made to remove the diseased mass completely whenever the surgeon is fortunate enough to find a tumor free from adhesions and glandular involvement. For all other cases the operations of gastro-enterostomy and entero-enterostomy are indicated, and with improved technique and increasing readiness to undertake these operations before the patient is worn out by suffering, far better results will be achieved in the future.

CARCINOMA OF THE RECTUM.—Lövinsohn, reporting 110 cases of cancer of the rectum from Czerny's clinic, tries to prove that hemorrhoids are one of the causes of that disease, but as they were present in only seventeen per cent. of his cases, the argument is not very strong when we take into consideration the frequency with which they occur. Williams, however, found seventeen cases of hemorrhoids in forty-two cases of rectal cancer in which the etiology was noted. There were twice as many men as women among Czerny's patients, but Williams, in sixty-four English cases, found the sexes represented equally. It is interesting to note that of twenty-seven autopsies Williams found no case in which there was more than one part of the rectum attacked. Metastasis occurred in the liver, as was to be expected, in twelve out of the fourteen cases in which it was found; while the lung and pleura were attacked in seven cases, the kidney in two, and the vertebræ, spleen, ovary, and breast each in one.

I have analyzed reports on the results of treatment of rectal cancer from various clinics, which give a total of 420 operations with a mortality of 15.5 per cent. It would be desirable to completely separate the operations done through the perineum from those in which the sacrum was attacked, but I have been unable to do this satisfactorily, owing to the manner in which the two methods have been confused in the reports.

For a careful study of their mortality and their results, operations on the rectum should be classified under a double division, first as to the part of the bowel removed, second as to the mode of reaching the seat of disease, for both of these points are important. It manifestly makes a great difference whether the entire circumference of the bowel is removed, or only a part, and whether the excision is made high up without affecting the anus, as in resection, or whether it removes the entire lower segment, as in amputation. But there are not as yet enough cases available for a complete study of this kind. As to the mode of exposure, the decision of the question as to the value of those methods of operation which divide the sacrum is most important. The method advocated by Kocher, of making a posterior incision from the anus to the base of the coccyx and removing this bone, simply amounts to a prolongation of the customary incision, and does not complicate the ordinary perineal operation sufficiently to require separate consideration. But the true sacral methods add an extensive injury to the bone, with all the increased dangers of prolonged operation, sepsis, and hemorrhage, and on the other hand they bring within the scope of the operation many cases of extensive disease which would not otherwise be attacked; consequently it is natural to expect, with these methods, a higher death-rate and a greater percentage of relapses. Czerny in

reporting his cases does not distinguish between cases operated upon according to the respective methods of Kocher and Kraske, and this appears to me to be an error.

In estimating the final results we shall do well to accept the four years' limit as the test of a cure. Taking the sacral and perineal operations together, in the 420 cases in my list, 144 patients were operated upon four years before the report: 32 of these died from the operation, and 13 were lost sight of, leaving 99 to test the question of recurrence; and of these 99, recurrence took place in 71 before the four years elapsed, while 28 remained free from disease. Calculating on the total number, including the fatal cases, but excluding the 13 lost sight of, the percentage of cures is 21.3. We might add that four patients of Krönlein's wanted from three to six months only of the four years' survival at the time of the report, and consequently, although healthy, could not be included, while three of Czerny's patients were again attacked by the disease three, four, and seven years after the first operation, so that they had to be included on the debit side of the account, and my estimate therefore of the operative results is certainly not too favorable.

The majority of these were perineal operations, and nearly all of the cures were the result of such procedures. But it must not be imagined that for this reason the operations were slight, or the cases all of a promising character. I have especially studied this point in the histories of forty-three cases of cures (estimated by the four-year limit) which were accessible, with the following results: twenty might be called favorable cases, being of tumors low down or with small attachments, but the rest were all serious, and in eight the operations were extensive and severe. For instance, in the last category from 12 to 18 centimetres of bowel were removed in several cases, the infiltrated vaginal septum was excised, the prostate was attacked, the prostate and seminal vesicles were partly removed, and in one instance a large tumor filled the rectum, involved the vagina, and compelled the opening of Douglas's pouch and the use of the curette on masses there which could not be cut away. In one case of Esmarch's there was a melanotic tumor, which returned subsequently in the inguinal glands, but after removal there did not again recur, the patient remaining well seven years after the first and five years after the second operation.

CARCINOMA OF THE BREAST.—Cancer of the breast, according to S. W. Gross, in a statistical study based upon 1622 cases, most frequently attacks individuals between forty and fifty years of age; and as his figures are nearly the same as those in all the later series of cases published, I have reduced them to a percentage basis and give them below:—

	20 to 30 Years.	31 to 40 Years.	41 to 50 Years.	51 to 60 Years.	61 to 70 Years.	71 Years and Upward.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
GROSS	2.2	16.5	37.3	30	12.2	1.4
POULSEN.						Totals.
Married	1.7	11.2	39	28.2	16	3.4 (231 cases).
Single	2.1	14.9	28.7	33	18	3.2 (94 cases).

I have added Poulsen's figures, which are remarkable as showing a great difference in the age of married and single women when attacked by the disease.

If Poulsen's figures should be borne out by larger numbers, the fact thus demonstrated would be very interesting. The proportion of married to single women attacked by the disease is, according to Gross, about the same as that in the general population, about eighty-five per cent. being married. Poulsen shows a different result, his cases including nearly thirty per cent. in single women, the 231 cases put down as among the married including some of the patients whose condition was not noted. Child-bearing and nursing appear to have no perceptible influence upon the liability to the disease. Thus Fink, in 168 married women, found 50 who had had six or more children, and 5 who were sterile; while Williams in 98 married women found 12 sterile, 4 who had had miscarriages only, and 14 with only one child—the difference being undoubtedly due to the greater fruitfulness of German as compared with English women, and indicating that it is unlikely that these conditions have anything to do with the causation of the disease. As an additional indication on this point I may mention that Poulsen (in the Copenhagen hospitals), besides finding nearly thirty per cent. of the patients single, found twenty-seven per cent. of the married women barren. Under the head of etiology, I have already spoken of the effects of traumatism and inflammation, and need not refer to them here. But it is worth noting that a case of carcinoma combined with tubercular mastitis has lately been put on record by Crawford.

As to the situation of the tumor in the breast, Gross found in 820 cases that twenty-eight per cent. lay centrally, and forty-six per cent. lay in the upper and outer portions. I have arranged his figures in the following diagram, which shows this truth very strikingly:

		Superior		
	206	90	55	
External	83	231	32	Internal
	32	51	40	
		Inferior		

The two breasts are equally liable to carcinoma, and in 2717 cases (Gross, Schmidt, Fink, Rapok, Schulthess, Dietrich, Poulsen, and Williams) I find the right breast affected in 47.5 per cent., and the left in 51.8 per cent. of the cases, while both breasts were diseased in 0.6 per cent.

The variety of structure in carcinoma of the breast is considerable, but the proportion of frequency in which the different varieties of the disease occur is difficult to state, because authorities differ so much in their nomenclature. Gross, in 669 cases, found 87.7 per cent. of ordinary carcinoma, 2.93 per cent. of encephaloid, and only 7.9 per cent. of scirrhus. Poulsen, on the other hand, calls 45.5 per cent. of his 154 cases scirrhus.

The cystic and colloid carcinomata are very rare. Simmonds has recently made a study of the colloid form, based on two new cases with eighteen collected from surgical literature, and their compara-

tively benign character is shown by the fact that four patients who were not operated upon lived from eleven to fourteen years. Although in sixteen cases treated by operation the axillary glands are only twice noted to have been affected, metastases do occur. The cases were not observed for a sufficient length of time to allow any idea to be formed of the ultimate results of operation. Simmonds describes the structure of these tumors as made up of dilated acini containing cell-nests in their centres, surrounded by a layer of colloid material lying between the epithelium and the walls of the acini, and cutting off its nutrition so that it dies and breaks up into granular detritus. He thinks it clear that the hyaline material comes from the epithelium. Dreyfuss, however, while agreeing in this last statement, finds colloid material in the epithelial cells and between them, as well as between them and the walls of the acini; and Masterman found colloid masses in the centre of the alveolus in one case, the epithelium remaining attached to its walls, while in another case this material lay in streaks between the cells throughout the acinus.

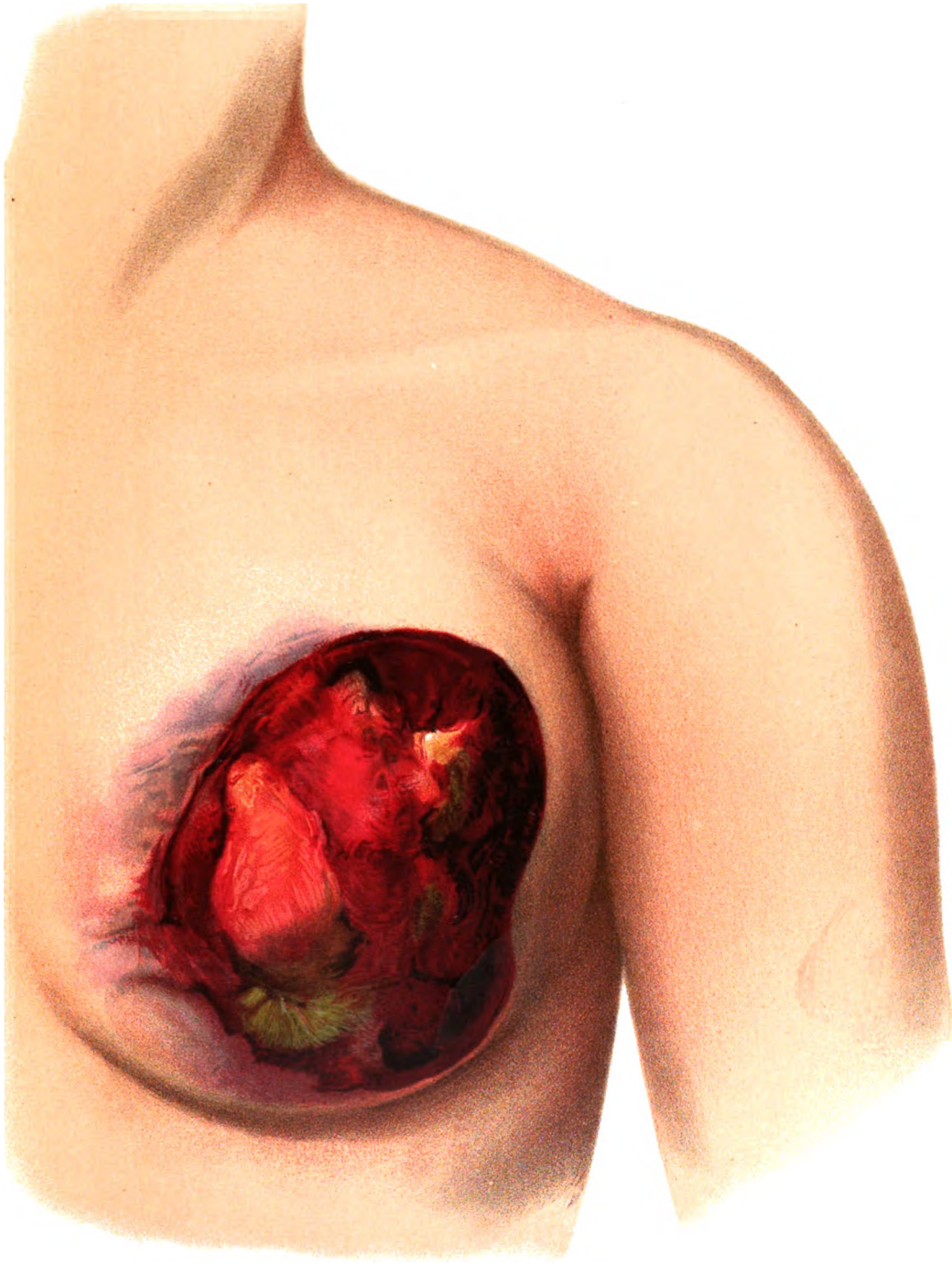
While discussing the pathology of tumors of the breast, it is necessary to recall the observations of Creighton on the comparative frequency with which carcinoma begins in certain very deep sebaceous glands of the skin, in the axilla. The origin of many cases in which the disease begins beyond the periphery of the breast is readily explained by referring it to these peculiar glands.

The rate of growth of mammary carcinoma is very variable, and while in a general way it may be said that the scirrhous variety is a slowly progressing form, and the encephaloid a rapid one, for the intermediate varieties it is not always true that the rate of growth is proportionate to the amount of epithelial as compared with that of connective tissue.

I append illustrations from two contrasting cases recently operated on by myself. The colored plate shows a fungating carcinoma of the breast, of only four months' growth, its microscopic structure being that of encephaloid, very rich in cells, with a scanty vascular stroma full of nuclei. Fig. 1604, on the other hand, illustrates an atrophying scirrhus of seven years or more in growth, occurring in a woman over 70 years of age. It had caused disappearance of the inner half of the mamma, but without ulceration. The nipple was somewhat retracted, but not involved, and the skin over the little mass of the tumor, just internal to the nipple, was red and adherent, but not ulcerated. The glands in the axilla were found enlarged, but examination after removal proved them to be free from carcinoma.

Gross says that the rate of growth is not affected by the age of the patient, in contradiction to the usually received opinion that cancer grows more rapidly in the young. The rate of growth is increased by the occurrence of pregnancy and lactation. As instances of slow growth, Poulsen cites one case of medullary carcinoma in which the tumor required ten years to reach the size of a hen's egg, and another in which the disease had involved the entire breast in the course of fifteen years.

A very thorough study of the mode of extension in carcinoma of the breast, recently made by Heidenhain, shows that the growth follows the line of the lymphatics and blood-vessels, attacking very early the fascia of the pectoralis muscle, penetrating that and continuing to

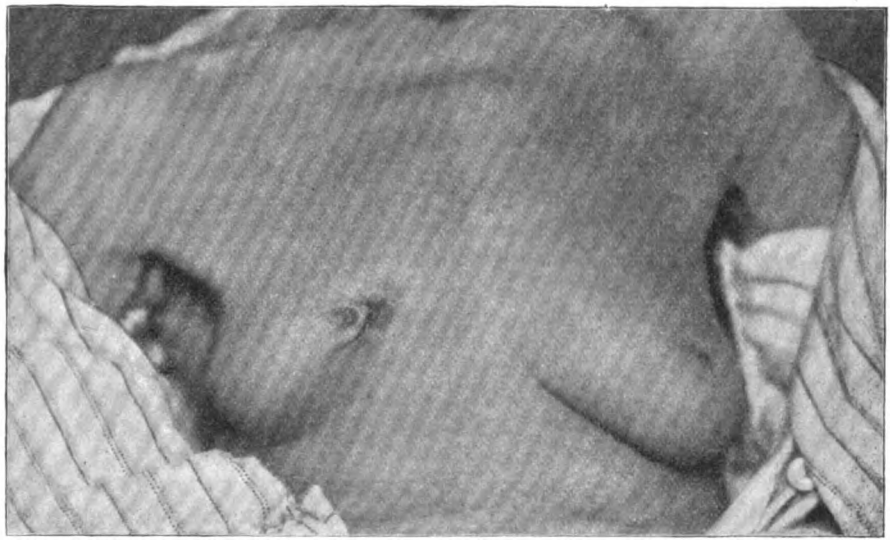


Carcinoma of the Breast - Curtis

spread in the connective tissue between the muscular fibres. When the muscle has once been invaded, it is impossible to determine by gross appearances how extensively it is diseased, and therefore the only safe method of treatment is a complete anatomical extirpation of the pectoralis, as well as of the breast itself, whenever this is adherent to the muscle, since it is then certain that the growth has begun in the latter. In every case the pectoral fascia should be removed with the breast, and dissected off in such a way as to remove with it a thin layer of muscular fibres, for it is rather indistinct in its boundaries, dipping down into septal prolongations between the muscular fasciculi.

The date of infection of the lymphatic glands and skin appears to be very variable. It is possible for the skin to be affected without any disease in the glands. Poulsen notes ten such cases in a series of twenty-one, cured by simple amputation without clearing out the axilla.

Fig. 1604.



Atrophic Scirrhus in a Woman Seventy Years Old.

In 206 cases in which this point was noted (from Schmidt and Dietrich), neither skin nor glands were involved in 4.3 per cent., the skin alone was invaded in 14.5 per cent., and the glands alone in 12 per cent., while in all the rest both were affected. The latest date at which both remained healthy is given by Schmidt as seven and one-third months, and by Hildebrand as eight and three-quarters months, but glandular affection may be delayed longer than this, being given by these authorities as eight, and as nine and three-quarter months, on the average. Gross, however, in his large collection makes the average date of glandular implication 14.7 months, and says, in contradiction to the figures just given, that it antedates invasion of the skin by a month. In a case of atrophying scirrhus Gross saw infection of the glands delayed for five years, and says that in one case on record it was absent up to seven years, as in my case just described. Poulsen, too, relates a case of scirrhus operated upon after the disease had lasted for seven years, the breast only being removed and the axilla left untouched, and yet the

patient continued in good health some years afterward, proving that the glands could not have been affected at the date of operation. He relates five other cases cured without attacking the axilla after the disease had existed over one year, and two similar cases in which the disease had existed for two and three years respectively before operation. Schmidt also relates four cases of one year's duration without glandular involvement, one case of two years' duration, and two cases of three. From these facts we must conclude that there are many exceptions to the general rule of early infection. Both Gross and Schmidt agree in the statement that the situation of the tumor in the breast does not influence the infection of the glands. As to the frequency of glandular involvement, adding to Gross's figures the cases of Schmidt, Fink, Dietrich, and Poulsen, we obtain a sum of 2304 cases, of which the glands were involved in sixty-nine per cent. at the time of operation.

Retraction of the nipple is one of the most characteristic and reliable symptoms of the presence of malignant disease in the breast, for Gross found it present in fifty-two per cent. of his own 207 cases, whereas among benign mammary tumors he found it buried by the growth (not really retracted) in only five per cent.

Metastasis is the rule in the later history of carcinoma of the breast, but it is absent in a large number of cases, death taking place in the latter from exhaustion, sepsis, or other effect of the local growth. Gross found that metastasis was present only in one-half of the cases which came to autopsy. Metastasis may occur as early as five months or as late as eight years in the history of the case, about one-quarter of the patients suffering from it within a year, one-quarter in the second year, one-quarter in the third, and the rest after the third year. Gross, in 423 autopsies, found recorded that the liver was involved in forty-nine per cent., the pleura in forty-two, the lung in forty-one (besides nine per cent. in which both lung and pleura were involved), the bones in twenty, the brain in nine, the other breast in eight, the dura mater in six, the kidney in six, and the uterus in five, while many other organs were less frequently affected.

Fig. 1605.

Carcinoma of Mamma in a Man Sixty Years of Age. Duration of disease twenty years without operative treatment.

The duration of the disease varies of course with the form of growth; but of 117 cases in which no operation was done, the average duration of life was 28.6 months, according to Gross, although Williams, in 34 cases not operated upon, found the duration of life much greater, being 44.8 months. The same difference appears in the estimates formed by these authors of the duration of life after operation, Gross in 536 cases placing it at 38.5 months, while Williams in thirty cases found the average life to be 60.8 months. Fig. 1605 shows a case of carcinoma of the breast in a man, not operated upon, and of remarkably slow growth according to the patient's statement.

In an article already referred to I have taken, from such original rec-

ords and case reports as were accessible to me, almost entirely from German sources, the totals of all cases of cancer of the breast in which operations had been performed more than three years before the date of the report; in other words, all those cases in which the patients had had a chance to remain free from recurrence for that time. The sum of these totals is 826 cases, in which 59 patients died from the operation and 767 recovered. Of the latter, 154 remained well, 529 had local recurrence or metastatic growths, and 82 were lost sight of or died of other causes in less than three years. Deducting the last set of 82 cases, we have a percentage of cures of 22.5 on the basis of the recovered cases only, or, including the deaths, a percentage of 20.7 on the total number of cases. In either case the result is better than one patient in five cured.

We may compare with these results the work of some of our own surgeons, although as full details have not been published I have been unable to include them in my tables. Dennis reports the results of 33 cases of amputation of the breast for carcinoma, with no deaths and 25 per cent. of cures; while Weir, in a series of 125 cases, also with no deaths, says that 20 per cent. of the 60 patients whose condition he was able to observe for three years had no recurrence. Bull[1] reports 108 cases with 4 deaths. In 75 cases the patients were operated upon three years or more before the date of the report, and of these 3 died from the operation, while 52 suffered from recurrence, and the remaining 20 continued healthy, giving 26.6 per cent. of cures—the best results on record. Angerer in 40 cases had a mortality of zero, and Poulsen gives the Copenhagen mortality as only 5 in 280 cases, or less than 2 per cent.; these are the lowest reported death-rates of foreign operators.

It would seem to be unnecessary at this late date to dwell upon the necessity for clearing out the axilla in every case of amputation of the breast for carcinoma, whether glands can be felt there or not, but since such authorities as Butlin and Treves still defend the old plan of leaving the axilla untouched unless enlarged glands can be felt, I must emphasize again the teaching of Volkmann, Gross, and Banks. Gross found that in 96 cases in which the patients were operated upon without touching the glands, and in which recurrence followed and its situation was noted, it took place in the cicatrix and vicinity only in 48 per cent., in the glands alone in 20 per cent., and in both in 32 per cent. In 313 cases, on the other hand, in which the axilla was cleared, the recurrence was local only in 75 per cent., in the glands alone in 12 per cent., and in both in 13 per cent. This shows a reduction of glandular recurrence from 52 to 25 per cent. by the clearing of the axilla, and is the best possible evidence of the usefulness of the practice. Gross maintains, in common with nearly all other recent writers, that enlargement of the glands exists even when they cannot be felt, and such was the case 14 out of 16 times in his own experience.

CARCINOMA OF THE UTERUS.—The results of treatment of carcinoma of the uterus have very greatly improved of late years, and I have obtained sufficient material to make at least a preliminary statement of these results. From the clinics of Schauta, Landau, Gusserow, Olshausen, Martin, Leopold, Hofmeier, Boldt, F. Krug, Fritsch, Kaltenbach,

[1] Medical Record, August 25, 1894.

Fehling, and Terrier and Hartmann, I find reported 798 cases of vaginal hysterectomy, and from those of Czerny, Schede, and Hochenegg 53 cases of sacral extirpation. The mortality after *vaginal hysterectomy* is 9.7 per cent., but in the hands of some operators it falls as low as 5 per cent. Of the cases which ended in recovery, the subsequent histories are known in 490, and in 198 of these recurrence took place, while 192 patients remained well but had not yet passed the three-year limit, and 100 had passed that limit in safety. There were therefore 26.4 per cent. of cures; or, deducting the fatal cases, 33.4 per cent. of the patients who recovered from the operation, and had not been lost sight of, were cured. From the same sources I have been able to classify separately complete lists of all the cases operated upon by certain of the operators (Fritsch, Fehling, Terrier and Hartmann, Schauta, and Leopold) previous to the three years immediately preceding their reports, thus excluding all cases in which the patients had not had the opportunity to reach the limit, there was a total of 156, with 15 deaths, 20 patients lost sight of, 60 recurrences, and 61 cures. This gives a percentage of 44.8 per cent. of cures in the cases kept under observation, or 50.4 per cent. of the cases in which the patients recovered. These numbers include, to be sure, the much-criticised results of Leopold, but also the rather unfavorable cases of Terrier and Hartmann, and even if we omit Leopold's cases the figures still remain 35.8 per cent., or, deducting the fatal cases, 41.3 per cent. The results of vaginal hysterectomy for cancer can therefore be said to be unusually good, certainly better than those of similar operations upon the breast.

The *sacral method in extirpation of the uterus* has been demonstrated to be feasible, and the mortality has fallen, so that Czerny lost only one in eight cases, although Schede, operating apparently in more desperate cases, lost eight out of 28. I have found only two cases of cure in the 53 on my list. The utility of the method is doubtful, for, as a rule, when the infiltration has extended so far as to contra-indicate vaginal extirpation, the sacral method will not suffice to remove all the disease. Those unusual cases in which the infiltration extends backward, and not into the broad ligaments, are the only ones in which the method can claim any natural rights.

Abdominal hysterectomy for cancer, although much more often done than formerly, and with constantly decreasing death-rate, has not as yet enough cases to its credit to enable one to speak authoritatively as to its merits.

The only operation which competes seriously with vaginal hysterectomy is *supravaginal amputation of the cervix.* Winter, including Schroeder's cases already published, found in 155 cases a mortality of ten, but in the last 64 cases not a single death. Excluding four patients operated upon within three years, he found 151 cases with 10 deaths, 80 recurrences (13 after the third year following operation), and 46 patients free from recurrences for three years or more. Omitting the cases lost sight of before the three-year limit, the cures amount to 32.4 per cent., or 34.8 per cent. of the recoveries. This is not quite as good a result as that just given for vaginal hysterectomy, even when Leopold's favorable showing is omitted.

Byrnes has recently claimed to have done 359 high amputations of the cervix with the *cautery*, within twenty years, with only 2 deaths

and 138 patients remaining well for three years or more, out of 201 whose fate was noted for that length of time. This would give a percentage of 68.6 per cent. of cures, an extraordinary record. Unfortunately he does not seem to have verified his diagnosis with the microscope, so that it is probable that these brilliant results may prove somewhat overdrawn. It is impossible to conceive how hot steel can be any better than cold steel in giving freedom from recurrence; certainly there is not as much tissue removed or destroyed by the cautery as in a properly performed vaginal hysterectomy.

CARCINOMA OF THE VAGINA.—Primary epithelial cancer of the vagina is a comparatively rare affection (Hecht found 50 cases among 4507 of cancer in women), and, contrary to what might be expected, it is even rarer in the prolapsed mucous membrane than in that part which is within the canal. Zizold suggests that this difference may be considered analogous to the more frequent occurrence of cancer of the glans penis when there is phimosis; but the parallel is a bad one, for even if the prolapsed mucous membrane is rendered tougher, it is also irritated by contact with the clothing, etc., whereas when remaining in the vaginal canal it is in its natural environment, and in spite of the secretions of the part is less irritated. On the other hand, the glans penis is not covered with true mucous membrane, and its exposure practically converts its covering into true skin, while when covered with the prepuce it is kept in a state of irritation by foul secretions, not being surrounded by normal mucus which has a free opportunity to escape, as is the case with the vaginal mucous membrane. Of the forty-five cases of malignant disease of the vagina collected by Zizold, in three it was caused by the abuse of pessaries. In one case on record the patient was only nine years of age, and two others were between fifteen and twenty, but nearly one-half of the whole number were from thirty to forty years old. The disease may be epithelioma or ordinary carcinoma, and in about two-thirds of the cases it is situated on the posterior wall. It often gives no symptoms until very far advanced, and in all twelve cases in which it was operated upon, probably from this reason, recurrence took place. In a case recently under my care the patient was unaware of the presence of the small vaginal ulcer which was the primary centre of disease, complaining only of the pains in her lower extremities due to secondary pelvic masses, and of a painful metastatic tumor in the skull.

CARCINOMA OF THE PENIS.—While some authors consider phimosis a frequent cause of carcinoma of the penis, claiming that 75 per cent. of their patients had narrow foreskins, others admit the occurrence of this peculiar formation in only 10 per cent., and consequently deny all etiological importance to this condition. The disease begins in the glans more frequently than in the prepuce, and generally infects the inguinal glands, but not at a very early period. In this situation apparently more often than in any other, the enlargement of the glands is inflammatory, for they have not infrequently been left untouched, and yet have not undergone further development. In two of Czerny's cases enlarged glands were removed, and were found to contain no carcinomatous tissue.

The results of treatment are very satisfactory, for in 66 cases reported by Partsch, Schick, and Keller (from the clinics of Bruns and Czerny), 18 patients remained well three years or more, and if we deduct 20 cases not observed for that length of time, we obtain the proportion of 39 per cent. of cures. This favorable result may undoubtedly be compared with that obtained in the treatment of epithelioma of the skin in the extremities, where the neoplasms also grow slowly, and where there is no obstacle to free removal of the affected parts. This is illustrated by Schick, for he found that of seven recurrences only one took place *in loco*, the disease in the remainder appearing again in the inguinal glands. The fact that infection of the glands does not prevent the surgeon from obtaining a cure, if they are thoroughly removed, is shown by Czerny's experience, for in 13 of his 17 cases the glands were affected, and in one other case they became enlarged after the operation, and yet he obtained 5 cures in the 14 cases observed for three years.

CARCINOMA OF THE BLADDER.—Southam and Railton, in 75 cases of primary carcinoma of the bladder, found only 20 in women. They consider secondary carcinoma less common than primary, which is contrary to general experience; thus Hasenclever (quoted by Roesen) found only 3 primary carcinomata of the bladder in 40 cases, and Zausch in 48 cases found only 14. According to the latter, the sexes stand 10 males to 4 females in the primary, and 7 males to 27 females in the secondary tumors. According to Fenwick, papilloma coexists with carcinoma in one-tenth of the cases, but he could not decide whether the papilloma was due to the irritation of the malignant growth, or whether the latter had developed from the former. Calculus has occasionally been found to be the cause of malignant neoplasms, and Roesen has recently reported a case of large stone of oxalate of lime, which must have antedated the carcinoma, and could not have been secondary to it as is frequently the case with soft phosphatic calculi. Curiously enough, in this case and in another observed by Roesen, the tumor was situated on the anterior wall, which is a rare situation. Southam reports a case of scirrhus of the bladder, a hitherto unknown form of growth in this organ.

Albarran, in a carefully collected series of 97 cases of operation with 43 deaths, was unable to find more than one cure. In two or three of the recurrent cases, however, the patients lived for two or three years. His list does not include the cases of more or less complete resection of the bladder, but only the less extensive operations. Among the resections, Pawlik's case, in a woman 56 years old, who remained well two and one-half years after complete extirpation of the bladder, deserves notice. In Bardenheuer's case (reported by Brohl), in a man, in which the entire mucous membrane was removed, the patient had a recurrence in the fistula a year or more after the operation.

CARCINOMA IN UNUSUAL SITUATIONS.—A form of carcinoma of the *neck* which is uncommon, but not as rare as has hitherto been supposed, is that arising from remnants of the *branchiogenic clefts*. The once hotly debated question of the possibility of primary carcinoma of the lymphatic glands has now been settled in the negative. Many of the cases upon which depended the argument for the affirmative were merely instances of unrecognized primary disease of very small size,

or in a concealed situation, and probably all the rest can be explained by accepting their origin from branchiogenic remains. To Volkmann, in 1882, must be given the credit of first describing carcinoma in this situation. Gussenbauer says that a carcinomatous tumor in the upper triangle of the neck, underlying the superficial fascia, with no primary neoplasm in the mouth or elsewhere to account for it, is probably branchiogenic in origin. He reports eight cases from his own experience alone. Richard reports three cases, with five collected from surgical literature, so that there are already sixteen cases of this newly recognized form of disease on record. The tumors lie deeply, in close contact with the great vessels and pneumogastric nerve, and frequently adherent to them. This makes their removal difficult, but Gussenbauer claims to have more than once removed portions of the vagus thus attached to the tumor, without perceptible effect, and suggests that the long-continued pressure had caused so much atrophy that the function of the nerve was practically destroyed, and that its division therefore did no harm. These branchiogenic carcinomata are usually of the epitheliomatous type, owing to their origin from flat epithelium, and they usually contain cell-nests. But occasionally they are formed of polyhedral cells, and are typical carcinomata. Many of the tumors have contained cysts, which had evidently existed before the carcinoma had developed, but others have been solid.

Primary carcinoma of the *trachea* is also rare. Pick, who reports a case, could only find fourteen others on record. The form is usually medullary in type, probably originating in the mucous glands, and hence usually seated where these are most frequent, on the posterior wall. In ten cases these neoplasms attained a size which required tracheotomy. Among the curiosities of neoplasms should be cited Letulle's case of primary pavement epithelioma occurring in the *mediastinum*, in a man sixty-five years old, a thorough post-mortem examination revealing no possible primary infection elsewhere. The growth had a tubular structure, and Letulle believed it to have originated from the thymus. Friedländer has put on record a very singular case of epithelioma occurring in a *phthisical lung cavity*, discovered at the autopsy, originating in the wall of the cavity and projecting into a bronchus. He explains its origin by the fact that tuberculous or syphilitic ulcers of the trachea are sometimes found with flat pavement epithelium at their edges, as the result of attempts at cicatrization, and supposes that in this case the growth began at the edge of an ulcer implicating the bronchial mucous membrane.

Primary carcinoma of the *urethra* and its neighborhood is very rare, Witzenshausen, who reports two cases, being able to find only four others recorded as occurring in the male; Rupprecht[1] adds four, including one of his own, and Albarran[2] one more, the total thus reaching eleven. Lester has reported a case in the female, occurring in annular form at the meatus, but this is quite a different clinical form of the disease. In the male cases severe urethral stricture has always preceded the malignant change. The growth is usually situated in the deep urethra, and while it causes early obstruction to the passage of urine, and gives rise to peri-urethral abscess, it seldom appears as an external tumor until very late. It is of the epitheliomatous type, but

[1] Centralblatt für Chirurgie, 1894, S. 1119. [2] Gazette des Hôpitaux, 1894, p. 1235.

invades the lymphatics early, and causes death in a few months' time. It is easily distinguished from carcinoma of *Cowper's glands*, which is another unusual seat for the new growth, Pietrzikowsky, who reports a case in this locality, being able to find only two others of undoubted authenticity on record. In his own case, which occurred in a young man of only nineteen years, and which had been of fourteen weeks' duration when seen, the inguinal lymphatic glands were already involved, and recurrence took place soon after operation. All three cases were marked by very little difficulty in the passage of urine, which is a typical symptom when the urethra is involved, but there was some obstruction to defecation occasioned by the rather large tumors lying between the perineum and the anus. The tumors also occasioned difficulty in walking. Lester has collected ten cases of "peri-urethral" carcinoma in the female, but most of these were simply instances of secondary disease spreading to that part by direct extension.

Results of Treatment in Carcinoma.

Summing up what has been detailed in the study of the disease in each organ, we may construct the following table:

Organ.	Operation.	Mortality Per Cent.	Cures Per Cent.	
			Ordinary.	Corrected.
Breast		2½ to 6	22.5	22.5
Uterus	Vaginal hysterectomy	9.7	26.4	44.8
	High cervical amputation	2 to 7	32.4	34.8
Rectum	Perineal	12	23	21.3[1]
	Sacral	20		
Tongue	By mouth	12	10	6.6[1]
	Kocher's method	14		
	Jaw resected or divided			
Larynx		30	5.8	
Skin	Face		24 to 68	
	Extremities		43	
Lip			47.5	
Penis			39	

These figures show that the best results are to be expected in the operative treatment of carcinoma of the skin, the uterus, and the penis. Next in order come the breast and the rectum, while the worst results are found in the tongue and the larynx.

What is to be considered a cure in a case of cancer? We can scarcely talk of a cure as long as there is any danger of recurrence, and it is exceedingly difficult to set a time limit when that danger shall have been passed. The great majority of recurrences appear within the first six or at most twelve months after operation, but many come in the second year, and a few in the third. After that date recurrence is not common, and yet quite a number of cases are on record in which the disease has reappeared at even a later period.

I do not include among cases of recurrence those in which the disease returns at some other point in the body, at a date too late to make it probable that there has been a metastasis from the original tumor—as in two cases of mammary carcinoma reported by Eders, in which the disease appeared in the remaining breasts four and seven years respec-

[1] Four years' limit.

tively after removal of the first. But true late recurrences are not uncommon. Plicque has collected thirteen cases of relapse after an interval of three years. Schmidt reports three cases of cancer of the breast relapsing in the fourth year after operation, one in the sixth, and one in the seventh. Fink reports three cases, Hildebrand two, Dietrich three, and Poulsen eight cases relapsing in three or more years. Partsch reports two cases of cancer of the lip recurring eight and ten years after operation. Fraenkel reported recently a case of a comparatively young woman, thirty-seven years of age, who had been under constant observation for eight years after a high amputation of the cervix uteri for epithelioma, and who finally developed a recurrence in the body of the organ. Then there is the well-known case of laryngectomy done by Hahn, in which the patient remained well for eight years, and then developed another cancer in the scar. In the rectum late recurrence appears to be especially common, cases having been reported by Volkmann, König, Kelsey, Böckel, Arnd, and Lövinsohn, of recurrence at intervals varying from three to eleven years. Cancer of the tongue also appears to offer a bad prognosis in this respect, recurrences after an interval of more than three years being reported from Billroth's and Volkmann's clinics, while Kocher had the misfortune to see a return in two of his cases ten and twelve years after operation. The same surgeon saw return of the disease in the scar, after laryngectomy, three years after the operation in four cases, and Billroth and Fischer had a similar experience in one case each.

Metastasis has usually been supposed to show itself very soon after the primary operation, but there are some cases on record which go to prove that it also may fail to declare itself for some years. In one of Poulsen's cases of mammary cancer the patient died of cancer of the stomach over five years after the operation on the breast, and three other patients died with signs of some internal recurrence in from three to six years. Schmidt reports a case of death by cancer of the lungs and liver seven years after removal of the breast, and Dietrich one of cancer of the uterus four years after a similar operation; in neither case was there any local return. Lövinsohn reports a case of cancer of the rectum in which the disease did not return *in loco*, but in which the patient died four years afterward of metastasis in the liver. The last case is perhaps not so very remarkable, for the liver infection might itself have been secondary to disease in the lymphatic glands, and thus might not have been very much longer in developing than usual. Some of the other cases can be explained as the growth of entirely independent tumors, and I should certainly so interpret the cases of late appearance of the disease in the other breast and in the pylorus. But there still remain some cases of recurrence in the lungs and liver which appear to be true late developments of secondary tumors.

It is therefore self-evident that the limit of two years set by the earlier writers is altogether too short to assure a cure, and it may be questioned whether even the limit of three years can be allowed to stand. It is true that the total number of cases recurring three years and more after the operation is very small, compared with the total number of operations for malignant disease; but it should be remembered that the proper basis of comparison is not the number of operations, but the number of patients who have been operated upon and

yet remain alive and free from disease three years or more afterward, and that number is comparatively small. Thus my lists show 180 patients alive and free from recurrence for three years or more after removal of the mamma for carcinoma, but they also show 23 cases in which there was a relapse after that period, or eleven per cent. of the cases observed over three years. For the rectum, the tongue, and the larynx, a four years' interval of freedom should certainly be required before a patient can even relatively be said to have been cured.

Taking all these facts into consideration, I have in this article required three years' freedom from recurrence before allowing that a case is cured, and for the tongue and the rectum I have set the limit at four years.

After the facts which I have been obliged to record of late return of the disease either *in loco*, or as the result of metastasis, and of repeated return after operations, it is necessary to throw a little more emphasis on the cheerful side of the picture by noting the comparatively large number of cases in which a cure has been established after a second or even several secondary operations. Plicque has put on record 97 such cases collected from various sources, but unfortunately I have been unable to obtain his thesis for study. But Poulsen records three cases in which two or more recurrent mammary carcinomata were removed in the first year or eighteen months, and yet the patients remained well from eight to nine and a half years after the last operation. He also mentions two cases in which recurrent growths, appearing one three and the other five and a half years after the first operation, were successfully removed, and in which the patients continued well respectively two and three and a half years subsequently. Gouley relates two cases of very late recurrence of carcinoma of the breast (20 and 25 years after the first operation), in which the patients remained well five years after the last operation; and adds a similar case of sarcoma. Parker records a case of amputation of the thigh for sarcoma recurring after amputation at the knee, in which the patient was well seven years after the second operation. Michael saw an epithelioma of the skin of the thigh recur twice, and the patient finally remain well nine years after the last operation. Similar cases of carcinoma in the rectum are recorded by Turner, Volkmann, Sihle, and Arnd. I have met with a personal experience which is very interesting in this respect. In January, 1890, I removed a slow-growing epithelioma from the floor of the mouth, in a man forty-nine years of age, removing at the time all the mucous membrane of the lower surface of the tongue, and all the tissues between the mouth and the skin under the jaw, leaving only the tongue above and the skin below. The bone was not affected at this time, but before he left the hospital a small growth had to be curetted from its inner surface. In December of the same year the patient returned with the lower jaw involved, and with a mass as large as a hen's egg over the great vessels of the neck on the same side. I found a large gland adherent to the internal jugular vein, and excised with it over an inch of that vessel; otherwise the mass was not adherent, and two weeks afterward, when the wound had healed, I removed the right half of the body of the lower jaw with the diseased tissues attached. He made a good recovery, and now, four years after the last operation, still remains perfectly well.

Such are the results of the operative treatment of cancer. In spite of the general and great improvement over those of former times, it must be acknowledged at the outset that even free removal is no sovereign remedy. It may be said with truth that if the disease is attacked in time it can be cured by a radical operation, but that single limitation prevents the universal success of operative treatment, for there must always remain the internal cancers which do not give symptoms until they are too far advanced to be completely eradicated, and also a large proportion of external tumors which, owing to the carelessness or ignorance of their victims, are not observed until it is too late for successful interference. As Winter puts it, supposing that one case in four of uterine cancer can be cured by operation, and only one case out of four which come to the surgeon is suitable for operation, we can save only one woman in sixteen of those attacked by the disease. We must therefore still desire a remedy which may cure the disease in any stage and in any situation, without damage to the surrounding parts, in some such way as mercury and potassium iodide act upon the lesions of syphilis. As we have seen in speaking of sarcoma, there appears to be some ground for hoping for an advance in this direction, since the experiments of Fehleisen, Spronck, and Coley have shown that at least in some cases it is possible to check the progress and even cause the absorption of malignant tumors by inoculation with the germs of erysipelas, or even by hypodermic injection of the sterilized products of cultures of these germs.

In the mean time, let us hold the advantage we have gained and try to increase it, as may undoubtedly be done. The first step toward the improvement of operative results must come through the family physician—the general practitioner. Not until he is fully convinced that an operation will cure the disease if attacked in the early stages, and not until he is able to make an early diagnosis, can we secure the full value of this method of treatment. On him depends the entire question. Winter interrogated 56 patients with uterine cancer who applied at the Frauenklinik in Berlin, and found that 47 of them had first had advice upon their symptoms, which were often vague enough at the beginning, from their family physicians, and that only one-third of the number reached the clinic in time for satisfactory operations. The reason was evident on closer questioning, for in only one-half of the cases had the attending physician made any immediate examination of the parts, and in one-third no examination whatever. It is not surprising, therefore, that of every fifteen only three were found suitable for an attempt at operative treatment.

The same holds true of carcinoma of the breast. In a very considerable proportion of the cases which I have seen, the patients have told me that their physicians had examined the tumor in the breast, and had declared that it was of no importance, that it would pass away, or would not grow larger, or had even given that commonly offered false explanation, "It is the change of life." Now it appears improbable that all of these physicians were so ignorant or so negligent as not to consider the possibility of cancer, and I believe that the chief reason for delay and neglect in such cases is the lack of faith in operative treatment, which not only prevents the physician from urging early operation, but acts indirectly by leading him to neglect the proper study of

a disease which he considers incurable, or at least to slight the examination and diagnosis of the cases in which he suspects its existence.

That this state of affairs is improving has also been shown by Winter, who says that, whereas in 1883 only 19 per cent. of the cases of uterine cancer seen by him were considered to have enough chance of cure to make an operation worth while, in 1891 37 per cent. of the cases were operated upon, and solely because the patients came at an earlier period of the disease. But it requires much further improvement before the results can be made much better. The delay on the part of the physician occurs most often in waiting to have his diagnosis made certain—waiting for evidence of growth in a tumor, or for glands to enlarge—before he has the courage to suggest an operation. As a matter of fact, his attitude should be the reverse, and whenever he is not absolutely certain that a tumor is innocent, he should recommend operation, or should at least seek the advice of those experienced in such cases. Now that we are able so easily to remove small portions of a growth and have an authoritative opinion upon its structure, a positive diagnosis can usually be made comparatively early, and the physician should remember that the very symptoms for which he waits in order to make a diagnosis are usually such as indicate that the case has already passed the favorable time for treatment; involved glands do not indeed contra-indicate operation, but they show that the disease has probably gone so far that the chances of cure are greatly diminished.

The ignorance and timidity of the public will of course always limit our efforts to obtain more favorable conditions for really curative operations, but improvement in this respect is also largely in the hands of the profession, whose power and duty it is to educate their patients, and to show them the importance of having competent advice and prompt treatment for all swellings, tumors, warts, ulcers, and slow-healing wounds, no matter how painless or trifling they may appear.

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VENEREAL DISEASES: GONORRHŒA.

BY

J. WILLIAM WHITE, M.D.,

PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF PENNSYLVANIA, SURGEON TO THE UNIVERSITY, PHILADELPHIA AND GERMAN HOSPITALS, PHILADELPHIA.

NATURE OF GONORRHŒA.

THE pathological and experimental arguments in favor of the specificity of gonorrhœa now far outweigh the clinical evidence heretofore adduced. While they fall short of actual demonstration of the invariable association of a definite micro-organism—the gonococcus of Neisser—and the symptoms of the disease, and while, further, the same micrococci, or others indistinguishable from them, have been found in various normal secretions, yet the almost constant presence, in acute urethritis of high grade, of large numbers of gonococci, and the fact that Bumm, Anfuso, Wertheim, and Gebhard have produced the disease by inoculation of pure cultures, would seem to show a definite relation.

The medico-legal value of this relation is, however, impaired by the fact that Lustgarten, Mannaberg, Legrain, Poney, and others have shown that the normal urethra may contain diplococci identical in all respects with Neisser's gonococci, found like them in epithelial and lymphoid cells, and having the same peculiarities as to staining, etc.

PATHOLOGY OF GONORRHŒA.

Brewer [1] describes as follows the pathological processes in an ordinary case of gonorrhœa: A small amount of purulent material containing gonococci is deposited during the sexual act upon the mucous membrane of the fossa navicularis. These living organisms penetrate the epithelial covering of the mucous membrane, and, finding their way through and between the superficial cells, eventually reach the upper stratum of the subepithelial connective tissue. The irritation caused by this microbian invasion results in an acute hyperæmia of the part, with dilatation of the capillary vessels and exudation of serum. There is also an increased glandular secretion with epithelial exfoliation. Subsequently, an abundant transudation of leucocytes takes place from the dilated capillary vessels. These, during their outward passage through the epithelial layer, absorb and carry with them large numbers of gonococci. If the urethra is examined at this time, the mucous membrane will be

[1] Morrow's Cyclopedia of Genito-Urinary Diseases, p. 151.

found to be thickened, deep red in color, and covered with an abundant muco-purulent or purulent secretion. The orifices of the mucous follicles appear as deeply injected, slightly elevated spots. Epithelial erosions and sometimes areas of genuine ulceration are present. The process begins in the fossa navicularis and gradually extends downward, reaching the bulbo-membranous junction about the twentieth day. When the wandering leucocytes have succeeded in removing the micro-organisms from the sub-epithelial tissue, the symptoms begin to subside. The hyperæmia diminishes, the sub-epithelial round-cell infiltration is absorbed, the erosions and ulcerations receive a new cellular covering, and the disease is at an end. Resolution takes place more slowly in the glands, which often continue to secrete pus long after the process has ceased in other portions of the mucous membrane.

Posterior Urethritis.

In many cases, either with or without the complications of the second stage, the disease will pass into the third or subsiding stage. In others, however, the inflammation, previously confined to the pendulous urethra, extends backward so as to involve that portion of the urethra between the bulbo-membranous region and the bladder. The compressor urethræ muscle may act as a bar to this backward extension, but it is thought that a more rational explanation of the not infrequent escape of this region is to be found in the fact that the membranous urethra is less vascular and less richly supplied with glands and follicles than other portions of the canal. It hence offers a less favorable ground for the development of micro-organisms. The symptoms of this accident are those associated with the accompanying prostato-cystitis. The complications are inflammations of Cowper's glands, of the prostate, and of the bladder.

Abortive Treatment of Gonorrhœa.

The increasing evidence in favor of the view that the gonococcus is the chief cause of gonorrhœa would naturally lead one to anticipate much benefit from the employment of antiseptics both as abortive and as curative agents. The latter question will be considered elsewhere. As to their efficacy in aborting the disease, there is thus far not much clinical evidence that is encouraging. Unfortunately, the results of culture experiments and of the influence of parasiticides upon gonococci external to the body do not afford satisfactory evidence as to the effect of the same agents when applied to the same germs embedded in the depths of an inflamed urethral mucous membrane. Bumm's investigations appear to show that, at first, these multiply by preference in the papillary layer, and find their way to the surface only during the latter part of the purulent, and during the subsiding (or muco-purulent) stage, and Finger uses this as a theoretical argument against the early administration of either astringents or antiseptics. Enough is known, however, to enable us to state with certainty that the agents which are effectual against the microbes of suppuration are not equally

destructive of the gonococci, several competent observers having noted the fact that antiseptic solutions, when applied to gonorrhœal secretions outside of the body, have seemed to exert but little effect upon the gonococcus, even when strong enough to destroy pus-cells almost immediately.

ANTISEPTIC TREATMENT.

When the ardor urinæ of the earliest stage of gonorrhœa has somewhat subsided, the time has arrived when the use of antisepsis is especially indicated.

Clinically, we may assume that at this stage, in the majority of cases of urethritis, gonococci, the microbes of suppuration, and other bacteria will be found intermingled, and that successful treatment by germicidal agents will involve the destruction of all the different varieties present. Dismissing theoretical considerations, we may inquire what drugs, if any, belonging to the class of antiseptics have a curative effect upon the essential symptom of urethritis—the blennorrhœa; restricting our inquiry to those cases in which the disease is comparatively acute, and in which it is limited to the pendulous urethra; in other words, to the ordinary cases of uncomplicated gonorrhœa which present themselves in one's office for treatment during the first few days after its appearance. The treatment of "posterior" urethritis need not be discussed in this relation.

Considering topical remedies first, and excluding a large number which have little or no claim to occupy time or attention, we may divide the remainder into three classes:

1. Those which when strong enough to exert a sufficient germicidal action, are locally so irritating as to be harmful or unbearable. This class includes nitrate of silver, carbolic acid, chloride of zinc, iodine, chloral, potassium permanganate, salicylic acid, and creasote, all of which have been faithfully tried in many cases and by competent surgeons, the concurrent testimony being, that when used in sufficient strength to sterilize the discharges they produce an amount of local irritation and swelling, ardor urinæ, chordee, and even exceptionally urethral ulceration, that far outweighs any advantage to be derived from their antiseptic properties.

2. Those which are such feeble antiseptic agents that they cannot be depended upon to destroy all the bacteria found in urethral discharges. Among these may be mentioned resorcin, thallin, quinine, the sulphate and acetate of zinc, lanolin, sulphur waters, tannin, alum, hydronaphthol, and cadmium sulphate. Both clinical and experimental evidence coincide as to most of these drugs. Each has had its more or less enthusiastic advocates, but when given a wider trial has been found disappointing, while bacteriologists have shown that its germicidal action is either limited to a very few varieties of bacteria, or is slow and uncertain.

3. The third class includes a number of agents which, while open to the same objection of too feeble or too limited antiseptic action, have the additional drawback of insolubility in ordinary media, and of occasionally becoming mechanically irritating from the formation of con-

cretions. Among these are iodoform, calomel, bismuth subnitrate, oxide of zinc, and other insoluble powders.

It must not be supposed that this list is intended to be even approximately complete. It might be increased literally a hundredfold, and nothing could better demonstrate the blind absurdity of empirical methods than the dozens of ridiculous formulæ and the hundreds of useless drugs which have from time to time been recommended for use in the various forms of urethritis.

So far, however, as they are antiseptics, they would be found in one or the other of the above classes.

There are certain agents which I have purposely omitted from this classification, but which, as ordinarily employed, might have been included with considerable propriety. These are corrosive sublimate, the sulpho-carbolate of zinc, boric acid, peroxide of hydrogen, and the salicylate of bismuth—the five drugs which in various combinations are, in my opinion, of the most practical value in attempting by topical treatment to secure asepsis in an inflamed urethra. Corrosive sublimate was used in the last century and in the early part of this century by Musitanus, Malow, Gardave, Benjamin Bell, John Hunter, Gutauer, and Swediaur. It then fell into disuse, but was revived again in 1846 by Mueller von Berneck, and was employed spasmodically and unsystematically by a few surgeons until Neisser's discovery of the gonococcus gave the drug an extraordinary vogue. The records of its effects in different hands have thus far been most contradictory. While on the one side we have Leistkow, Lewin, Eichsbaum, Grandin, Chameron, Paul, Louissot, Keyser, and Macrae advocating its employment, on the other we have Diday, Wyeth, Dujardin-Beaumetz, Lewis, Finger, Auspitz, Bardezzi, Du Castel, Dreyfous, and Fournier, who either recognize no advantage from its use, or who record positively unfavorable experiences. Its employment by the method of irrigation in solutions varying in strength from 1 in 60,000 to 1 in 10,000 has been popularized by the excellent work of Curtis, Halsted, Vanderpoel, and Brewer, and their published results seem to warrant its further trial, especially in hospital and dispensary practice.

The method of deep irrigation or retrojection involving the use of a catheter has always been unsatisfactory in my hands in private practice. It involves too much expenditure of time on the part of both patient and surgeon, and in a genuine acute inflammatory urethritis is certainly objectionable on account of the irritation produced by even the softest instrument. Keyes and others have met with cases of cystitis, prostatic abscess, epididymitis, and other complications which seem to have been produced by this treatment used early in attacks of urethritis. Palmer has called attention to its inapplicability to private practice, and I can add my testimony to that of these writers, though I am aware that in forty-six cases treated by retrojection Dr. Brewer claims to have met with no difficulty.

I find it much more satisfactory to order frequent injections from a large syringe employed with moderate force, using the strongest solutions that can be given without causing pain, and preventing the liquid from passing too deeply by instructing the patient to sit upon a folded towel during the injection, so as to occlude the membranous urethra. My results as to sublimate were, however, disappointing as long as I

used this drug alone. In a certain proportion of cases, by no means a small one, any solution, however weak, seemed to irritate, giving rise not so much to pain at the time of injection as to subsequent increased ardor urinæ. In others the treatment was well borne but had no influence upon the discharge; in others it aggravated this; and those in which it caused very decided improvement were in the small minority. Rigid dietetic and hygienic directions were always given at the same time, and were, as a rule, fairly well followed, as most of the patients were of good social position.

Boric acid, recommended long ago by Hyndman, of Cincinnati, and tried by Chameron, Du Castel, and others with unfavorable results, was used by me in a considerable number of cases six or eight years ago, and and was dropped on account of the general negative character of its effects. It has been shown to have little effect on the gonococcus, but it is quite unirritating, and can be used in sufficiently strong solution to destroy many of the weaker forms of vegetable life. Its germicidal action is slow but continuous. I shall allude hereafter to its internal employment. I certainly improved my results when I added it to the bichloride injection in the proportion of about fifteen grains to the ounce. I felt, however, the additional need of an astringent, and for a long time employed the sulphate of zinc, for which I afterward substituted the sulpho-carbolate (from two to ten grains to the ounce of the mixture). By adding a ten or fifteen per cent. solution of peroxide of hydrogen in varying strengths, I then found that I had a formula which, both clinically and experimentally, showed excellent antiseptic qualities. In exceptional cases of profuse catarrhal secretion the addition of bismuth salicylate was also of advantage.

The formula which I now employ is as follows:

℞ Hydrarg. bichloridi..... gr. $\frac{1}{30}$–gr. $\frac{1}{10}$.
Acid. boric..... ʒ i.–ʒ iss.
Zinci sulpho-carbolat..... gr. xviij.–ʒ ss.
Liq. hydrogen. peroxid..... f ʒ i.–f ʒ iij.
Aquæ ros.....q. s. ad f ʒ vi.

The rigid application of the antiseptic principle by means of these drugs, used in this way, has undoubtedly brought about a distinct gain in my results; complications are fewer, and the time required for cure is shorter, than when I was content with employing sedatives and astringents and with endeavoring to meet symptomatic indications, but there is still much to be desired.

INTERNAL ANTISEPSIS.—In quite a large proportion of cases it is not possible to use this injection, or any modification of it, for some days after the disease has reached its height. Under these circumstances, boric acid combined with potassium bromide and belladonna in a solution of potassium citrate, while it never has any very marked effect upon the amount of discharge, usually moderates the ardor urinæ, chordee, and vesical tenesmus of the inflamatory stage.

INTERNAL REMEDIES.

There can be little doubt that the beneficial action of cubebs, copaiba, and oil of sandalwood, as well as that of their congeners, gurjun, kava

kava, eucalyptus, and the various terebinthinates, is chiefly due to their antiseptic powers, which not only deprive the altered and partially sterilized urine which contains them of many of its harmful properties, but cause it to exert a positively curative effect upon the suppurating mucous membrane. This statement is borne out by a number of microscopic observations upon specimens of urine before and after the administration of these drugs, and by culture and inoculation experiments.

I have been led by the publications of Dreyfous,[1] Sahli,[2] Bouchard,[3] Lane,[4] and Nencki (quoted by Bouchard) to add salol to the drugs employed in the routine treatment of gonorrhœa.

Dreyfous's paper contained the results of his observations in seven cases in which salol had been administered in full doses both with and without admixture with cubebs and copaiba.

Sahli had shown that the resultants of the intestinal decomposition of salol were salicylic and carbolic acids, which were eliminated by the kidneys. He had exposed to the air for some weeks the urine of a patient under the influence of salol without the least decomposition occurring. Nencki had made the same observation. Bouchard called attention to the value of the simultaneous employment of several antiseptics by internal administration.

Lane reported excellent results in fifty cases of gonorrhœa in which he had used salol in doses varying from 5 to 30 grains three times daily.

I have not succeeded in getting quite such good effects from this drug as have been reported by others, but I am satisfied that its use has been of unmistakable benefit to my patients, diminishing the average duration of the cases, reducing the discomfort and suffering, and lessening the frequency of complications.

I have given it almost invariably in the form of a capsule in combination with cubebs and copaiba:

℞ Salol	5 to 10 grs.
Oleoresin of cubebs,	5 grs.
Para balsam of copaiba	10 grs.
Pepsin	1 gr.

The conclusions at which I arrived after a preliminary trial of antiseptics, locally and internally,[5] are justified by my later experiences and are as follows:—

1. The results of antiseptic treatment are not so uniformly successful as might be expected, on account of, *a*, the anatomical and physiological peculiarities of the male urethra; *b*, the difficulty of applying sufficiently energetic local antisepsis; *c*, the necessarily intermittent character of such applications, and, *d*, the failure to combine with the topical treatment appropriate internal medication.

2. No one antiseptic agent can be depended upon, in the strength at which it can be borne by the inflamed urethral mucous membrane, completely to sterilize the discharges and the suppurating surfaces. A judicious combination of several antiseptics, if not essential to success, is at least of considerable value.

3. The internal administration of salol in conjunction with copaiba

[1] Gaz. Hebd. de Méd. et de Chir., 4 et 11 Janv., 1890.
[2] La Semaine Médicale, 7 Avril, 1886.
[3] Thér. des Maladies Infectieuses, 1889: Antisepsie, p. 247.
[4] Lancet, March 22, 1890.
[5] Medical News, June 14, 1890.

and cubebs renders the urine aseptic, and probably antiseptic, so that it acts as an exceptionally thorough and efficient antiseptic injection, shortening the duration of the disease and diminishing the frequency and severity of its complications.

TREATMENT OF POSTEROR URETHRITIS.

"Posterior" urethritis requires for its treatment, as a rule, the use of full-sized steel sounds and the instillation into the prostato-membranous urethra of solutions of silver nitrate varying in strength from 1 to 5 per cent. These combined measures rarely fail to effect a cure, but occasionally other injections or irrigations may be used with advantage. Sulphate of thallin in the strength of from 3 to 24 per cent. has been strongly recommended by Goll, of Zurich, and by Keyes, but I have had no experience with it.

VENEREAL DISEASES: THE SIMPLE VENEREAL ULCER OR CHANCROID.

BY

F. R. STURGIS, M.D.,

OF NEW YORK.

Varieties of Chancroid.

Dr. Fernand Lavergne, in the *Annales de Dermatologie et Syphiligraphie* for 1883, calls attention to a variety of the simple venereal ulcer which he has styled the papular chancroid. Its peculiarity consists in being slightly elevated instead of depressed beneath the tissues, and it closely resembles a syphilitic papule. The diagnosis is based in part on the coexistence upon the same subject of other varieties of chancroid, and it is found in both men and women. Lavergne calls attention to the fact that in the museum of the St. Louis Hospital there is a specimen of simple papular chancroid of the vulva.

Inoculability of the Chancroid and of Chancroidal Buboes.

At the International Congress of Dermatology and Syphilography, held in Paris in 1889, Ducrey read a paper in which he arrived at the following conclusions:—

1. That the chancroid is possessed of a specific and definite poison;
2. That this virus has not yet been artificially cultivated, although it has been produced by inoculation in man; it corresponds with a micro-organism which has not yet been artificially developed in the usual nutritive materials; and
3. That this micro-organism, which up to the present time has been regarded as the cause of the chancroid, and which is not easy to cultivate, appears not to be identical with the microbe which is the real cause of the chancroid.

For some time very little was heard about this question of the microbe, until Welander published in the *Archiv für Dermatologie und Syphilographie*, 1889, a paper in which he claimed to have found the bacilli in the pustules of inoculation, though they were not found in all specimens, and when present were present in very small quantities, whence he did not regard them as of great pathological importance. In 1891, Krefting, in the *Nordiskt Medicinskt Arkiv*, published the result of a

series of inoculations made upon fourteen patients. He found the results much the same as Ducrey had found, to wit, that in pustules produced by successive inoculations the presence of a microbe similar to that found by Ducrey could always be demonstrated. The attempts to cultivate this microbe were negative. He found, on examining sections of excised chancroids, that he was unable to demonstrate the presence of these microbes, and the difficulty he thought existed in the fact that these bacilli could not exist in alcohol, even if very much diluted, and that they were very difficult indeed to color by any of the then known methods.

Jullien, in 1892, communicated to the "Société de Dermatologie et Syphiligraphie," at Paris, the fact that he had made experimental inoculations after the manner of Ducrey and Krefting, and had been led to believe that the chancroids which he had used were not very virulent, and that inoculation would not go beyond the third generation. In 1892, in the July number of the *Monatshefte für praktische Dermatologie*, Unna showed that, by using a method of coloration consisting of a mixture of glycerin and ether, he had demonstrated the existence of a bacterium which he called the streptobacillus of the soft chancre. Unna did not positively state that this bacillus was identical with those which Ducrey and Krefting had discovered, but he noted that these bacilli, during their period of increase, formed in the tissues more or less elongated chains, and that they were nearly always found in the lymphatic interspaces of the cellular tissue. He never found any migratory cells. Krefting, again in 1892, in the *Archiv für Dermatologie und Syphilographie, Ergänzungshefte*, showed that in subsequent researches he had always been able to find the same bacillus, and also had found this bacillus in a virulent bubo which had been opened under cover, as well as in the pustules which were produced by inoculation of the pus from this bubo both before and after it had been opened. The attempt at culture, however, of either variety of pus, whether of inoculation or from the bubo, gave a negative result. In making his experiments Krefting first used for the purpose of discoloring his sections Unna's mixture of glycerin and ether. This, however, he afterward gave up for a preparation of the oil of anilin and xylol, for the purpose of discoloration, while for staining he used the alkaline solution of borax and methyl blue indicated by Unna, and in the preparations of chancroid thus made, he found bacilli in more or less numbers seated about the borders of the ulcerations, and in many instances penetrating through a zone of infiltrated cellular tissue surrounding the ulceration, and encroaching upon sound tissue. As Unna has pointed out, these bacilli are more frequently disposed in more or less elongated chains, but nevertheless they are sometimes found as small rods, which latter, however, do not always present the rounded extremities which were found in the bacilli derived from the chancroidal secretion as distinct from the tissues of the ulceration.

His conclusions with regard to this question of the microbe of the chancroid are, that its presence is demonstrable in the pustules of inoculation, and in the secretions of virulent buboes as well as in the artificial inoculations made with the pus from such buboes, and that it is moreover found in great numbers in sections made of excised chancroids. Although there is very little doubt that a peculiar microbe has

been found in the secretion and in the tissues of the chancroid, it is yet too soon to determine absolutely its relative importance as regards the question of inoculation.

VIRULENCE OF CHANCROIDAL BUBOES.

Within the last few years very various opinions have been expressed with regard to the question of whether the buboes which occur with the chancroid are virulent by absorption, or virulent by subsequent inoculation, and upon this question M. Straus, in the *Annales de Dermatologie et Syphiligraphie* for 1885, published his views in full. The conclusion at which he arrives is that there are not two kinds of bubo, accompanying the soft chancre, but only one, and that this bubo is never originally virulent, but only becomes so by secondary inoculation after the bubo is opened. He instances Ricord's experiments made from 1831 to 1837, in which out of 338 cases of bubo he obtained 271 successful inoculations. In 42 of these the pus of the bubo inoculated the day it was opened proved to be virulent. In 229 others positive results were only obtained by inoculation of the pus taken from one to several days after the opening of the bubo, and in these cases the inoculations made at the time of the opening of the bubo were negative. This view of M. Straus was vigorously combated by M. Horteloup at the "Société de Dermatologie," in December, 1884, as reported in the *Annales de Dermatologie et Syphiligraphie*. He considered that M. Straus had been very fortunate in his clinical experience with the bubo, but at the same time thought that he was a little premature in absolutely denying the existence of the chancroidal variety, and cited evidence in favor of the existence of the chancroidal bubo, which he thought invalidated the theory of M. Straus.

The case occurred in a hospital patient who entered for a bubo following a chancroid of the frenum. This chancroid had lasted for fifteen days. At that time the patient had noticed upon the right side of the frenum a little pustule which became denuded and converted into an ulceration. Three days after having observed this ulceration a phimosis occurred. On the 18th of November a sharp pain was felt in the right groin, and on the next day a swelling was observed at that point. Upon the patient's entry into hospital it was noticed that there was a complete phimosis which prevented the glans penis from being thoroughly exposed, and that there was besides an inflammatory swelling of the foreskin, together with a tender point on a level with the frænum and a sanio-purulent discharge. In the right inguinal region there was a tumor of large size, the skin covering which was of a purple hue and very thin. Fluctuation throughout its substance was complete, but there was no peripheric induration. The case was diagnosticated as one of chancroid of the frænum, and in accordance with the clinical characteristics of the bubo itself, its sudden appearance, its rapid march, its peculiar coloration, and the thinness of the skin, this latter was considered as a chancroidal bubo.

Under treatment the phimosis diminished, and as soon the glans penis could be uncovered the existence of a chancroid which had destroyed a portion of the frænum was seen. The bubo was opened on the 29th day after the patient had entered the hospital. "After having taken all

antiseptic precautions," says M. Horteloup, "both as regards washing my hands in carbolated water and in sterilizing the skin covering the bubo with a carbolated solution of one part in fifty, I incised the bubo with a new bistoury which had previously been thoroughly washed in carbolated water. The bubo was immediately evacuated, the pus being sanious, tinged with red and of the color of chocolate. With the same bistoury I made an inoculation 3 cm. from the umbilicus, having first thoroughly sterilized the skin covering the abdomen. This point of inoculation was covered with a watch-glass. The inguinal wound was cleaned out with lint soaked in carbolated water, and a dressing was made with prepared cotton taken from a new package and exposed to a carbolated spray for several minutes. The whole dressing was kept in place by a bandage soaked in carbolated water. The patient was then put back in his bed and he was strictly forbidden in any way to touch the watch-glass which covered the inoculation. On the 1st of December the dressing was removed, and the auto-inoculation of the day before was without result. The suppuration of the bubo had not been very abundant. The walls of the cavity were irregular in shape, but the borders had become ulcerated. About 1 cm. from the first inoculation a second one was made with a new bistoury, taking care to allow the blood to flow well before putting the pus upon the wound which had been made. A watch-glass, kept in place by diachylon, and the prepared carbolated cotton as before covered the bubo, and all of these dressings were kept in place by a carbolated bandage. The same precautions were taken in regard to interference or meddling with the inoculation. On the 4th of December the dressings were removed, and it was found that the inoculation of December 1 had been successful, a purulent vesicle surrounded with an inflammatory areola being seen. The pus from this first inoculation was taken and inoculated at a fresh point 5 cm. from the original point of inoculation, after all antiseptic precautions had been taken, and also pus from the bubo was taken and a fresh inoculation made in the abdominal wall to the left of the umbilicus. The borders of the inguinal incision had become scalloped and ulcerated, presenting the clinical aspects of a chancroidal bubo. On the 6th of December the chancroid which resulted from the inoculation made on the 1st had become very pronounced. Reinoculation of the matter of this chancroid had given rise to a whitish vesicle which was surrounded by an inflammatory areola. The third inoculation from the pus of the bubo also gave positive results. On the 8th of December, these various inoculations continued to follow a regular course, and their clinical characteristics did not differ from those which are found in the simple chancroid." M. Horteloup concluded that, while admitting that this complication of the chancroid was very much less frequent than certain statistics would lead one to suppose, it nevertheless unfortunately did exist, and in communicating this observation he wished to accentuate the fact that virulence of buboes is often too lightly thought about, and that consequently too favorable a prognosis is given in such cases, even after the open bubo has been dressed by absolute occlusion.

Diday in the same journal also protests against the view of M. Straus, and considers that there are buboes by absorption independent of the question of auto-inoculation.

Mannino, in a communication made to the Royal Academy of Medical Sciences of Balano, in Italy, and reported in the *Annales de Dermatologie et Syphiligraphie* for 1885, boldly takes his stand with M. Straus in disbelieving in the spontaneous existence of the chancroidal bubo, and he gives as the result of his investigations the following points: In 24 patients who had an inguinal bubo and in whom the bubo showed all the characteristics of the chancroidal variety, as well as of the simple chancroid, inoculation was practised at the moment of opening the buboes, with the pus coming from both the superficial and deep parts of the ulceration. All antiseptic precautions were taken, both as regards the hands and the instruments used, and Mannino says that in all of these 24 cases he had not seen any ulcerations produced upon those portions of the body where he had inoculated the pus of the bubo. The results of his inoculations had always been negative. He then repeated the inoculation in all these 24 cases forty-eight hours or three days after the opening of the buboes, and only in two cases did he obtain a positive result. In the other 22 cases the results of these second inoculations were also negative. Mannino also examined the pus of the chancroids microscopically, as well as that coming from the buboes at the time of their opening, and he noticed in all 24 cases a large quantity of microbes in the pus cells as well as in the fluid surrounding them. These microbes he considered to be micrococci united in chains, sometimes surrounding the cells themselves, and his conclusions in regard to this question are:—

1. That the pus of the bubo which accompanies the simple chancre is not inoculable at the time that the bubo is opened.
2. In certain cases this pus acquires virulent characteristics from forty-eight hours to three days after the opening of the bubo.
3. That in the pus of the chancroid bacilli are plentifully found in the shape of large numbers of micrococci united in chains, or sparsely scattered over the field.
4. That the pus of the bubo immediately after its opening has never been found to contain bacilli, nor micrococci, nor diplococci.
5. That the pus of the chancroid, when this latter has become a simple wound, no longer contains bacilli.
6. On examining the pus of the bubo, after it has become chancroidal, the bacillus of the chancroid has disappeared; and
7. That the poison of the chancroid loses its virulence when it has been submitted to the action of heat, more or less prolonged, at a temperature of 35 to 40° C. (95 to 104° F.).

Gemy in the *Annales de Dermatologie et Syphiligraphie*, 1885, gives as a *résumé* of 20 inoculations which he had made, 4 in which the results were positive, 3 in which they were doubtful, and 13 in which they were absolutely negative, and his conclusions are as follows:—

1. The simple chancre (chancroid) in a certain number of cases has no complications, as far as the groins are concerned.
2. When it is accompanied by an adenitis, this is purely inflammatory in about three-fourths of the cases, and the pus which it contains is not virulent. In the other quarter of the cases the bubo is the product of the transportation of a micro-organism, the contagious agent, through the lymphatic vessels, this being retained in the first set of inguinal ganglia and there producing chancroidal bubo.

3. In the last instance two phenomena may result. Either the bubo is chancroidal throughout its whole glandular tissue, but the periglandular cellular tissue is not as yet contaminated by the presence of the virus; pus from such a bubo is immediately inoculable. Or else the cellular tissue first becomes inflamed, and then, as it is this simple pus which escapes first after the opening of the bubo, the gland itself not becoming immediately chancroidal, a negative result is produced so far as inoculation is concerned; but it becomes positive if attempts at inoculation are delayed until this simple pus has entirely escaped and nothing but the interglandular pus, or else that which comes immediately from the ganglion itself, is employed.

Many cases might be cited in support or refutation of this theory, which, after all, sifts itself down to the following points:—

1. That in the large proportion of cases of chancroids of the genitals no glandular infection occurs.

2. That of those in which it does occur, the larger proportion are purely inflammatory at the beginning, and a very few of them may become virulent by carelessness in dressing the wound of the genital chancroids.

3. That a small proportion of them are virulent from the start, and this would seem to be borne out by the fact that occasionally, where the chancroids are virulent, there will be a virulent absorption, with breaking down of one or more of the lymphatics connecting the two points of ulceration. Such instances are not very frequent, but they have occurred.

Treatment of the Chancroid.

The treatment of this variety of venereal ulcer is as varied as that of gonorrhœa, every one having some pet drug which he deems *facile princeps* the thing to use, and which he thinks no chancroid, it matters not how inflammatory or angry it may be, can possibly withstand. One of the latest methods is the use of heat, which, by the way, is not a new thing. Aubert, surgeon-in-chief of the Antiquaille Hospital of Lyons, France, in the *Lyon Médical* for August, 1883, gives his opinion of the action of heat in depriving the chancroid of its inoculable virus, and says that heat, which he employed in the shape of hot baths beginning at from 42° to 43° C. (108° to 110° F.) completely destroys the inoculability of the virus after twenty-four hours. After the first twenty-four hours the heat may be reduced from 42° to 38° C. (100° F.) with continued happy results. Aubert prosecuted his experiments further in order to find the lowest point at which the virus was innocuous, and he discovered, or thought he discovered, that the chancroidal virus was rendered non-inoculable after the application of heat between 37° and 38° C. (98° to 100° F.) for several hours, that is to say, by a temperature at or slightly above that of the interior of the human body. He subjected the pus of the chancroid to a microscopic examination, and while he found that before the application of the heat at high temperature the secretion of the chancroid was purulent, after the application, even when carried only to 37° or 38° C. (98° to 100° F.), the pus corpuscles were found to be absent, and in place of them there was a simple

granular detritus, attended with a fetid odor and containing numerous bubbles of gas.

While, undoubtedly, the action of hot water, applied in repeated baths, will often exercise a very happy effect in reducing inflammation and causing cicatrization of chancroids, this is not a method that commends itself either for the facility of its employment or for its speediness in curing, and Diday of Lyons, in the same journal, ridicules the deductions drawn by M. Aubert as to the action of heat in producing a cure and reducing the chances of inoculability of the chancroid. He does not deny its value as a therapeutic agent, but asks, if heat neutralizes the virulent properties of the chancroid while cold has the opposite effect, why it is that the face and head, which are parts of the body more exposed, and suffering probably from a lower temperature, than the rest of the body, should be the places of all others where the chancroid is very seldom found, whereas, if Aubert's theory were true, the cephalic chancroid ought to be of frequent occurrence; and why also is it that a chancroid seated upon the glans penis and covered over by a tight foreskin, where, as far as the question of heat is concerned the conditions would be most favorable for cure, is so liable to accident and to be attacked by acute and virulent inflammation? Cavazzani, in the *Giornale Italiana delle Malattie veneree della Pelle, etc.*, 1892, recommends an admixture of hydrate of chloral, 5 parts, camphor, 3 parts, and glycerin, 25 parts, as a dressing for the chancroid, and declares that it produces a most happy result. He recommends that the camphor and chloral shall be rubbed up together in a mortar, the glycerin then added, and the whole put over a sand-bath for a quarter of an hour. He claims excellent results from this remedy.

For the treatment of buboes, Otis, in the *Journal of Cutaneous and Genito-Urinary Diseases*, 1893, recommends evacuation of the abscess by puncturing with a narrow bistoury, and the subsequent introduction, after irrigation of the cavity with a solution of mercuric chloride one part in 1000, of a warm iodoform ointment, ten per cent., the subsequent dressings to be wet in the bichloride solution; and he claims that of 16 patients thus treated 9 were reported cured in six days, 3 in twelve, 1 in fourteen, 1 in twenty-three, and 2 unknown. He claims for this procedure the following advantages:—

1. That it is simple and safe.
2. That in suitable cases, cure, as a rule, seems to be more rapid than by any other method.
3. That the patient is not prevented from going about during treatment.
4. That the first gland being rendered thoroughly aseptic, renders it less likely that the other glands in the chain shall become infected.
5. That it leaves no telltale scar. (In the present style of dress this point could really be of comparatively no importance.)
6. That it in no way interferes with any subsequent surgical procedure, should such be deemed advisable.

In the *Medical and Surgical Reports of the Boston City Hospital* for 1894, Dr. Watson reports 22 cases of bubo treated by excision and the use of sutures, securing union of the wound by adhesion. He reports that in a little less than fifty per cent. perfect primary union was

obtained. The following rules were carefully followed out in these cases:—

1. To thoroughly remove all diseased tissue and to leave, as far as possible, a perfectly healthy surface, in every part of the wound.
2. To excise such portions of the skin as threatened to be necrotic, or had already become so.
3. To thoroughly cleanse the under surface of the skin flaps; and
4. To thoroughly swab the whole wound with dry sterilized iodoform gauze. The flaps were then brought together by sutures, and the results, as claimed by Watson, were those stated above.

This method might answer very well indeed in cases of non-virulent bubo, but in cases where buboes were virulent, of course very little, if any, result could probably be obtained.

VENEREAL DISEASES: SYPHILIS.

BY

ARTHUR VAN HARLINGEN, M.D.,

PROFESSOR OF DISEASES OF THE SKIN IN THE PHILADELPHIA POLYCLINIC; PHYSICIAN TO THE DEPARTMENT FOR SKIN DISEASES, HOWARD HOSPITAL, PHILADELPHIA.

CHANCRE.

HERPETIFORM CHANCRE.—This almost always appears on the mucous membrane of the glans penis or on that of the prepuce, or on both at once. It is a very deceptive lesion, because it first shows itself very shortly after coition, and at first presents only the appearance of herpes genitalis. Little by little its real character appears. The herpetic lesion becomes covered with a pseudo-membranous deposit, its base becomes gradually infiltrated, and if multiple the herpetic erosions coalesce, become elevated above the surrounding surface, and finally take on all the characters of a syphilitic initial lesion. Meantime the inguinal glands gradually become engorged in a typical manner.

The multiplicity of the herpetic chancre is one of its most characteristic features. Mauriac has seen as many as twenty on the balanic mucous membrane.

MIXED CHANCRE.—When an individual has been inoculated with the virus of chancroid and syphilis simultaneously, or with only a few days' interval, the following symptoms are observed:—

At the end of thirty-six or forty-eight hours a sore appears, having all the properties of a chancroid, that is to say, being auto-inoculable, having around it, perhaps, other small ulcerations, and, at a little distance lymphangeitis, virulent adenitis, buboes, etc.

After four or five weeks, however, the aspect of the sore changes. Induration about its base sets in, and without losing its chancroidal character the sore takes on the aspect of a syphilitic lesion with its generalized symptoms following. Of course if the patient has already had syphilis, inoculation with this mixed virus will only give rise to chancroid.

The interval between the development of the two kinds of virus depends on the dates of their respective reception. If an individual is infected with syphilis on the first day of the month and with chancroid in the same place on the last day of the same month, the two poisons will break out almost simultaneously. Mauriac[1] gives numerous examples of mixed infection at various dates.

[1] Nouvelles Leçons sur les Maladies Vénériennes, p. 335. Paris, 1890

RELATIVE FREQUENCY OF CHANCRE IN DIFFERENT LOCALITIES.—The following figures may be compared with those given in Vol. II., pages 354, 355, 358:—

SEAT OF GENITAL AND EXTRA-GENITAL CHANCRES.

IN THE MALE.[1]		IN THE FEMALE.[2]	
Prepuce and glans	1343	Labia majora	140
Sulcus of the glans	217	Labia minora	39
Meatus	89	Fourchette	15
Urethra	17	Preputium clitoridis	17
Scrotum	20	Clitoris	16
Base of the penis	10	Entrance of the vagina	15
Anus	12	Meatus of the urethra	4
Abdomen	9	Neck of the uterus	22
Thighs	1	Superior commissure of the vulva	2
Lower limbs	3	Anus	5
Fingers	2	Thighs	1
Lips	36	Lips	9
Gums	1	Velum of the palate	1
Tongue	8	Tonsils	1
Cheek and nose	3	Breasts	2
Eyelids	2	Vagina	3
	1773		292

VAGINAL CHANCRE.—Gardillon[3] reports four cases. One of these occupied the posterior cul-de-sac; another, the right cul-de-sac; a third was situated behind the vulvo-vaginal ring on the posterior wall of the vagina; the fourth at the junction of the posterior and middle thirds.

The vaginal chancre is painless and excites no functional disturbance. The accompanying adenopathy occupies the groins when the chancre is in the lower third of the vagina, and the smaller pelvic basin when it is in the other two-thirds. The vaginal chancre heals spontaneously in one or two weeks, according to Gardillon, but the period is probably computed from the moment that the lesion has reached its maximum development.

The diagnosis of chancre of the vagina is not difficult, if the lesion is attentively studied. The chancroid of the vagina, which, like the chancre, runs a rapid course and heals spontaneously, is generally multiple, non-indurated, and presents the appearance of a true ulcer, with sharply cut edges and uneven base, secreting an abundance of pus; it may be inoculated upon its bearer, and is usually accompanied by vulvar chancroids of a similar appearance. Vaginal chancres must be distinguished from herpetic erosions, and from ulcerative or erosive syphilodermata, chiefly by the history of their development.[4]

DIAGNOSIS OF CHANCRE.—Leloir says that when an herpetic ulcer is pressed between the fingers, a drop of serous fluid is squeezed out. This manipulation can be repeated several times with the same effect. In the case of chancre, on the contrary, a little fluid is seen on the surface, but the quantity is not increased by pressure. When the base of

[1] Combined statistics of Martineau and Fournier.

[2] Combined statistics of Bassereau, Clerc Le Fort and Fournier.

[3] Essai sur le Chancre du Vagin, Chancre non-infectant et Chancre infectant. Thèse de Paris, 1881.

[4] See also Bockhart (a very curious and instructive case, with references), Monatshefte f. prakt. Dermatol., Dec., 1885, S. 417; and Rasmussen, Vierteljahrssch. f. Derm. und Syph., 1880, S. 517, abstracted by me in Phil. Med. Times, March 26, 1881, p. 401.

the herpetic ulcer is indurated, the hardened tissues can be flattened between the fingers, while in chancre no amount of pressure can change the nodule.

TREATMENT OF CHANCRE.—Although indolence is characteristic of by far the greater number of cases of chancre, yet at times the initial lesion of syphilis is so painful as to require special treatment with the view of allaying this symptom.

Usually the pain is connected with some inflammatory condition, and in such cases local or general sedatives will relieve the symptoms. Occasionally, however, the trouble seems to be due to some lesion of the nerves in the immediate neighborhood of the chancre, and then excision, when practicable, seems to be the only means of allaying the pain.

Chancres of the clitoris, it is said, are peculiarly apt to be painful, a circumstance which seems not unlikely when we consider the very abundant nerve supply of this part. Possibly cocaine, externally or by injection, would give relief in painful chancres of this locality.

SYPHILIS OF THE CIRCULATORY SYSTEM.

SYPHILIS OF THE HEART.[1]—According to Jullien, syphilitic affections of the heart develop, on an average, about ten years after the commencement of the disease. In six cases, however, among those noted by this author, the affection occurred as early as the end of the first year, while in others it developed as late as the eighteenth year of the disease. Men are much more liable to the affection than women. Age does not seem to have any influence in determining this form of syphilis.

The *prognosis* of syphilitic disease of the heart is grave. The affection usually develops in a slow, continuous, and insidious manner. Occasionally, however, attacks of syncope occur, leading to a dangerous condition, and sometimes to a sudden fatal termination. This occurrence is very frequent, having been observed in half the cases reported. At other times a slowly fatal process sets in, involving engorgement of the liver and lungs, with hydrothorax, ascites, etc. Death not unfrequently occurs through involvement of the brain. In some cases a favorable result may occur with or without partial dilatation of the heart.

In the *treatment* of syphilitic heart disease, digitalis and similar remedies are useless. Mercurial inunction, with the internal use of iodide of potassium, are indispensable. These remedies should be begun early and pushed vigorously; life or death may depend on the promptitude of treatment.

A strict milk diet is recommended in syphilitic heart disease, because it lessens the gastro-intestinal troubles and increases diuresis, while indirectly, by its diminution of ascites and meteorism, it removes some of the provoking causes of dyspnœa and angina.

The soothing effects of precordial blisters, while marked in other forms of heart disease, are not obtained in syphilitic heart affections.[2]

[1] Reference may be made to an excellent monograph by Lang: Die Syphilis des Herzens, Wien, 1889, and to the papers of Janeway (The Medical Recorder, 1872), and of Loomis (quoted by Bumstead and Taylor). Mauriac also gives a number of references.

[2] Zakharine. (Editorial article, Med. News., Phila., Oct., 1890, from Rev. Gén. de Chir. et de Thérap., 20 Août, 1890.)

SYPHILIS OF THE BLOOD-VESSELS.—The question whether syphilis may occasion aortic aneurism has been much discussed, but it is now generally conceded that this is possible. Jaccoud[1] says that though the ultimate prognosis of syphilitic arteritis is unfavorable, long remissions may be procured by appropriate treatment.[2]

Hutchinson[3] describes a case of coldness and lividity of the fingers of one hand, closely resembling Raynaud's disease and occurring in a syphilitic patient, which was cured by specific treatment.

In the earlier stages of syphilitic arterial disease prompt and vigorous treatment may cure the lesion by resolution. After a certain length of time the new growth breaks down and ulcerates, or more frequently becomes transformed into cicatricial tissue. All hope of cure is then at an end.

Angina pectoris of syphilitic origin has been observed, sometimes complicated with other troubles of innervation involving the vasomotor system.[4] I have noticed this symptom in a single case.

TREATMENT OF SYPHILIS.

Of late years the hypodermic method has been extensively employed in the treatment of syphilis, almost every possible salt of mercury having been essayed.

When first experimented with, mercurial hypodermic injections were often followed by untoward results: pain, inflammatory reaction, abscesses, phlegmon, gangrene, etc. More recently, however, such accidents have become rare and may in most cases be avoided. Fournier[5] gives the following suggestions to this effect:—

1. Caustic and extremely irritant compounds of mercury are to be avoided.

2. All solutions should be perfectly, chemically pure, filtered, sterilized, and aseptic. Many accidents may be referred to the introduction of septic germs in the process of hypodermic medication.

3. The instruments employed must be very carefully purified. The syringe to be used should be so constructed that it may readily be sterilized. The needle should be somewhat more than an inch in length, so that it can be inserted deeply into the tissues, and should be made of some not readily oxidizable metal. The point should be kept perfectly smooth and sharp.

4. In performing the injection the strictest antiseptic precautions are to be employed as regards the instruments, the operator's hands, and the surface of the skin.

5. The injection should be deeply made, superficial being much more likely to result in pain and inflammation than deep injections. Intramuscular injections are best.

6. Certain localities are more tolerant of mercurial injection than others. The posterior surface of the trunk is the least sensitive, and

[1] Leçons de Clinique Méd., Gaz. des Hôp., Fév. et Mai, 1886, Juin, 1887; and Aortite et anèvrysme de l'aorte d'origine syphilitique, La Semaine Méd., 1887.

[2] See also Knight, Syphilis and Aneurism, Archives of Medicine, New York, 1883.

[3] Lond. Med. Times, March 15, 1884.

[4] Hallopeau, Annales de Dermatologie et de Syphiligraphie, Déc., 1887.

[5] Traitement de la Syphilis. Paris, 1894.

the retro-trochanterian fossa is said to be also a convenient locality. The arms and legs are to be avoided.

7. After the needle has been plunged into the tissues, a moment's pause may be made to ascertain if a blood-vessel has been wounded. If a drop of blood appears, the injection should not be proceeded with. If not, the syringe may be attached, and from fifteen to twenty drops of the fluid may then be very slowly thrown in.

8. If numerous injections are to be made, they should be spaced at intervals of at least an inch.

Soluble salts of mercury are usually employed for hypodermic injection, and of these the bichloride is that most commonly used. Lewin's formula, which I prefer, is essentially as follows:

℞ Hydrarg. chlor. corrosiv., ... gr. viij.
Sodii chloridi., ... gr. xv.
Aquæ destillat., ... f ʒ iij.
M.

Fifteen minims of this solution represents about one-twelfth of a grain of the bichloride of mercury.

French syphilologists prefer the preparation known as the peptonate of mercury.[1]

[1] For further details regarding the various salts of mercury, see Fournier, op. cit., and L. Wolff, Proceedings Phila. County Medical Society, April 25, 1894.

SURGICAL DISEASES OF THE SKIN AND ITS APPENDAGES.

BY

J. ABBOTT CANTRELL, M.D.,

PROFESSOR OF DISEASES OF THE SKIN IN THE POLYCLINIC HOSPITAL AND COLLEGE FOR GRADUATES IN MEDICINE; PHYSICIAN FOR SKIN DISEASES TO THE SOUTHERN DISPENSARY, PHILADELPHIA.

THE following pages are intended as a supplement to the valuable article of Dr. J. C. White in Vol. III. The section on *molluscum contagiosum* has been entirely rewritten; there has been added a new section devoted to the description of *psorospermosis;* numerous minor additions have been made; and favorite forms of treatment, which have stood the test of years, have been described.

AFFECTIONS OF THE SEBACEOUS GLANDS.

MILIUM.—*Treatment.*—The removal of these structures can usually be accomplished by making a slight incision in their most prominent part, and then expressing their contents by pressure applied to either side by means of the finger-nail or the edge of a knife. The bleeding is easily checked by direct pressure on the part. The application of the green soap (*Sapo viridis*), of German manufacture, exerts a curative effect by removing the upper layer of the epidermis and allowing the contents to escape. Electrolysis, applied as in removing superfluous hair from the face, is followed by a rapid disappearance of the morbid condition.

MOLLUSCUM CONTAGIOSUM. Synonyms: *Molluscum sebaceum; Epithelioma molluscum* (Virchow); *Acne varioliformis* (Bazin); *Condyloma subcutaneum.*—The contagiousness of this affection, which was maintained by Bateman after having witnessed it in three persons in whom he had traced the source of contagion to a fourth, has been the occasion of decided controversy for some years. Numerous inoculations, which are said to have been successful, have been recorded. The disease is marked by small or large, from pin-head to large pea-sized, semiglobular, raised or somewhat flattened, so-called tumors of the skin, which as a rule are shiny and transparent, and of a pinkish or lilac color, but often have the appearance of a common warty growth. The lesions in most instances are sessile, but often pedunculated; at

times they show an umbilicated appearance, resembling the condition found in varicella. For the most part they are found occupying the face, but may be seen in remote regions, such as the neck and genitalia, and in rare instances are scattered over the entire body in small or large numbers. They are of slow growth. Their course is chronic, although they may disappear spontaneously. They are usually unaccompanied by any sensation of the part, except when they are accidentally the seat of inflammation, by which they are often destroyed. Although usually observed in children, they may be found among those of adult life. Expressing the contents of one of these little tumors, we find a somewhat thickened, white, opaque and cream-like material, the sac remaining hollow and flaccid. They have thus a resemblance to the ordinary sebaceous cyst, although the contents do not have the yellowish appearance of the material within the latter, nor do they have the characters of disordered sebum.

Examined microscopically and chemically, we find neither fat, cholesterin, epithelial scales, nor earthy salts, but the creamy material is found to be composed of an oval transparent structure, having a pinkish lustre and without a nucleus. In fact, in these little bodies we see the molluscum corpuscles which have so often been described.

These bodies, first recognized by Wilson in 1842, were well described by him. They were subsequently rediscovered at the Hôpital Saint Louis, being at this time described as cryptogamic spores, and believed to be the source of the contagion. This view, according to the observations of Pye-Smith, is incorrect, because their size, appearance, and reaction to potassa, with their inability to undergo development, contradict such a supposition. Pye-Smith believes them to be epidermic cells which have undergone hyaline transformation.

In most cases a certain amount of sebaceous substance is found in these tumors, but in other instances this is entirely wanting. Upon examination of a horizontal section the structure is found to be composed of several lobules, and in some cases we see a central cavity which somewhat resembles a sebaceous gland.

Whether the cysts originate in the sebaceous glands, or whether their metamorphic cells arise from the lining of the acini, is a matter of doubt. Virchow believes that the tumor is a new growth which is entirely confined to the deeper cells of the epidermis, and that there is no connection with the sebaceous glands. The earlier view seems to be the more correct one, and Sangster in his observations has entirely confirmed it.

Within a short time Darier, followed by others, has claimed that the element of contagion lies not in a bacterium or fungus, but in a "psorosperm," but this fact is not evident in all the specimens examined, although in some instances it certainly looks as if the cells were attacked by parasites. But we should have more confirmatory evidence of their existence before accepting this theory altogether.

Treatment.—One means of treating these tumors, when they are pervious, is by forcibly pressing the opposite sides and thus expressing their contents; the bleeding that often follows this mode of treatment is very slight. When the cysts are entirely closed, and when they are small, sulphur ointment often gives good results; and when larger they may be scooped out with the dermal curette, or removed by means of curved

scissors or the knife. When very numerous and closely packed together, the use of the German or of the domestic soft soap may, by causing exfoliation of the epidermis and discharge of the contents, result in a rapid cure. The application of caustic potassa or silver nitrate to the interior of the cyst, after squeezing out its contents, is at times admissible. The use of electricity, by means of the galvanic current applied as in the operation for removal of superfluous hair, may be tried in all cases with advantage.

Inflammations of the Skin.

Dermatitis Venenata.—The action of chlorine, used in the form of the solution of chlorinated soda (Labarraque's solution), will commonly effect a cure in four or five days. It may be applied in full strength, except in a decidedly acute case, when a weaker solution will be preferable.

Hypertrophies.

Callosities.—Tyloma may be congenital. Five cases of this form of disease have been described by Unna under the name of *keratoma palmare et plantare hereditarium.* Crocker[1] has also recorded similar cases to which he has given the name of *ichthyosis palmaris et plantaris.* The internal use of arsenic, when long continued, may give rise to this affection, and it may likewise probably be caused by hyperidrosis.

Treatment.—After soaking the feet in warm water and paring down the callosity with a knife, a plaster of salicylic acid, twenty per cent., or salicylic acid dissolved in collodion or ether, will cause maceration of the hardened tissue which can then readily be removed.

Clavus.—*Treatment.*—Should the patient object to the pain of cutting, salicylic acid plaster may be applied until the thickened layer becomes softened and can be removed. The following is a favorite remedy much in vogue: ℞ Acidi salicylici, ʒiss; Extr. cannabis ind., gr. x; Collodii, q. s. ad fʒi. This should be painted on with a brush, three times daily, for one week; the feet should then be soaked in hot water, when the corn can be picked out.

Warts.—Although not absolutely proven, it would appear probable that warts were contagious. A very striking example of contagion occurred in Payne's case; after having removed a wart with his nail, he noticed that subsequently one developed under the nail, and some on the dorsal surface of the thumb.

Treatment.—Among other remedies may be mentioned the internal use of Fowler's solution of arsenic, in the dose of ♏ij t. d. for adults and ♏ℓ for children. Recently sulphate of magnesium has been given, 2 or 3 grains for children, and ʒss for adults. Crocker thinks that nitromuriatic acid in full doses acts well at times. Condylomata of larger size may be removed with Paquelin's cautery. Salicylic acid in

[1] British Journal of Dermatology, vol. iii., 1891, p. 169.

the form of a rubber plaster, may be advantageously employed, or the following prescription may be used: ℞ Acid. salicyl., ʒss; Ext. cannabis ind., gr. x; Collodii, f ʒi. M. This is to be applied for three or four days, and the wart is then to be scraped. The removal of the larger, vascular warts is best accomplished by the ligature, galvano-caustic wire, or écraseur; to stop the bleeding which follows, perchloride or persulphate of iron, and pressure, will be sufficient. Liquor sodæ chlorinatæ, diluted, may be employed in the treatment of venereal warts occurring about the labia, to be followed by the application of calomel in powder, resorcin, or burnt alum and savin, equal parts. Van Harlingen recommends the following prescription for patches of warts: ℞ Pulv. acidi arsenios., gr. vi; Ung. hydrarg., Empl. hydrarg. āā q. s. ad ʒij. It is best to apply this salve on thin kid skin; it must not be used over too large an area at a time, as absorption may take place.

Diseases of the Nails.

Onychia Syphilitica.—During the secondary and tertiary stages of syphilis the disease frequently manifests itself by various lesions of the nails and their immediate surroundings, and these lesions may be mild or severe, and transient or permanent in their effects, according to the intensity of the localization of the specific virus in this portion of the body. At the best the affection is chronic, and the management of these cases may become exceedingly tedious and unsatisfactory.

Etiology.—This form of onychia is due, as has been said, to inoculation of the specific virus of syphilis, and develops as one of the later manifestations of that systemic condition.

Symptoms.—Clinically, the affection most commonly appears in the dry or friable form, called by the French *onyxis craquelée*, in which the implicated nail presents a lustreless and dry appearance, becomes yellowish-gray in color, exceedingly friable, and irregularly thickened, with furrows and ridges alternating upon its distorted surface. These depressions in the nail are due to a form of disintegration and dry rotting of the nail substance, and their formation is accompanied by a corresponding rolling upward of the edges of the nail, the condition being just the reverse of that seen in onychauxis. It must be borne in mind, however, that the coexistence of onychia and onychauxis is frequently noted, and this distinction therefore cannot be regarded as of diagnostic importance. Very often the tissues surrounding the nail present a congested, purplish appearance, with some desquamation of the surface, and pressure made upon this purplish rim may cause a few drops of unhealthy-looking pus to exude. It is claimed by some syphilographers that this condition is most frequently encountered among women. At times, without any manifestations of inflammatory action in the surrounding parts, the nails may become loosened and may finally be shed, the whole process being unattended with subjective signs, as in the case of syphilitic alopecia. When onychauxis is associated with this condition, the nail may assume a size three or four times that of the normal, and to this form has been given the name of hypertrophic onychia. As has been indicated above, syphilitic onychia is frequently associated with a form of paronychia or inflammatory disease of the tissues in

which the nail is embedded, and to this associated condition may be due most of the symptoms complained of by the patient. The inflammation in these softer tissues may go on to superficial ulceration, with purulent or sanguinolent discharge and crust formation, and slight burrowing of the secretion under the nail. Owing to the involvement of the matrix the nail shows evidence of impaired nutrition. The finger in such a condition presents a characteristic appearance due to the swollen and bulb-like form of the distal phalanx. Frequently in this form of syphilitic onychia the nail may become dislocated or entirely separated from its attachments.

Diagnosis.—The syphilitic history of the case will generally simplify the diagnosis of this condition. In the bulbous form, with associated paronychia, the disease must not be confounded with digital chancre, the nail in the latter affection not being the seat of the main trouble, nor with parasitic disease due to the presence of the trichophyton fungus (*trichophytosis unguium*).

The *prognosis* depends upon the early administration of the proper treatment. The disease may be arrested if promptly recognized and vigorously combated.

Treatment.—The treatment should be mainly internal, supplemented with antisyphilitic applications. The iodides and mercurials should be pressed to the utmost limit. Locally, Hyde recommends the white precipitate salve (one scruple to the ounce) applied on linen cloths. Applications of silver nitrate will have a beneficial effect upon the indolent ulcer, and these should be followed by iodoform, iodol, or europhen in powdered form. The local applications should be persisted in as long as there is any sign of inflammatory action, and even after this has disappeared internal medication must be urged.

TREATMENT OF INGROWING NAIL.—The surface, after the nail has been removed, may be dressed with iodoform, iodol, or a mercurial, such as the ung. hydrarg. oxid. rubr., and moist boric lint should then be applied and covered with oiled silk. Internally, quinine in full doses and a nourishing diet are indicated.

DISEASES OF THE HAIR.

HIRSUTIES. Synonyms: *Hypertrichiasis; Polytrichia; Trichauxis; Hypertrophy of the hair.*

In the condition known as trichiasis, which may be either congenital or acquired, the eyelashes grow in a backward direction and are a source of great irritation to the eyeball.

Treatment of Hirsuties.—When galvanism is employed the positive pole should never be used, as permanent scars would follow. When the parts are very sensitive, cocaine hydrochlorate (20 per cent.) and lanolin, in ointment form, may be rubbed in before operating, or cocaine may be used hypodermically, though its employment sometimes gives rise to alarming symptoms. Generally speaking, the coarser hairs only should be operated on; the lanugo hairs should not be touched. Hardaway employs a needle made of iridium and platinum; he says that it is easier to find the papilla with this needle than with one made

of steel. Other operators use a fine jeweller's broach, selected with care, and No. 5 or No. 7 in size. The use of depilatories is not advisable, as already mentioned. The following formula is recommended by Duhring: ℞ Barii sulphidi, ʒij; Pulv. zinci oxidi, Pulv. amyli, āā ʒiij. This is to be made into a thin paste with water, and applied to the hairy part; after ten or fifteen minutes or as soon as the skin commences to feel warm, the paste is washed off and a soothing ointment applied. Anderson uses the following: ℞ Barii sulphatis, ʒiss; Zinci oxidi, ʒ vi; carmine, gr. i. Water is applied to some of this powder and made into a paste; after remaining in contact with the parts for three minutes it should be washed off.

Elephantiasis Arabum.

Acromegaly may be regarded as a rare form of elephantiasis; in this variety the bones of the hands, feet, and face become hypertrophied; some of the fibro-cartilages also, as those of the ear and larynx, and all the tissues undergo enlargement and thickening.

Treatment of Elephantiasis.—The internal administration of quinine, particularly in marshy localities, should not be omitted. Cases in which the swelling is not extensive, or in which the solid deposits in the tissues have existed for only a short time, will be benefited by massage, which procedure tends to cause absorption. Potassium iodide also has its advocates in the treatment of this affection.

The administration of calcium sulphide in from 3 to 6 grain doses daily, has been followed by good results in lymph scrotum. It is thought that this drug destroys the parasite (filaria) in the blood and lymph channels. Change from a hot to a moderate climate often has a beneficial effect in cases in which the hypertrophy has not become very marked, and renders the prognosis more favorable. While in advanced cases of this disease the prospect is unfavorable as to perfect recovery, a fatal termination is decidedly rare, although in severe cases death may sometimes ensue.

Acne Hypertrophica.

As effective causes of this disorder may be mentioned dyspepsia, debility, nervous prostration, and compression of the vessels at the base of the neck by means of the clothing, tumors, etc., thus interfering with the circulation of the blood and giving rise to dilatation of the veins.

Treatment.—The following is the formula for what is known as Kummerfeld's lotion, which is of great benefit in the treatment of this affection: ℞ Sulph. præcip., ʒ i; Pulv. camphoræ, gr. v; Pulv. tragacanth, gr. x; Aq. calcis, Aq. rosarum, āā f ʒ i. This mixture has decided astringent properties, and exercises a very beneficial action on the rosaceous condition.

Keloid and Hypertrophy of Cicatrices.

Electrolysis has been recommended by Hardaway. Multiple punctures are made with a needle into and some distance around the growth;

a mild current should be used, and the needle must not remain in contact with the parts too long, for fear of aggravating the conditions.

Brocq also speaks well of this method in cases of hypertrophied cicatrix.

Fibromata.

These are sometimes congenital. When fibromata exhibit a tendency to hang in soft, loose folds, due to hypertrophy and excessive development of the cutaneous and subcutaneous structures, they are designated *fibromata pendula*, which is a more appropriate term than dermatolysis.

Xanthoma.

This disease is not a common one. The term *xanthoma multiplex* has been given to that form of the malady in which multiple xanthomatous lesions are generally distributed.[1] When the lesions occur in striæ, they are designated by the name of *xanthoma lineare vel striatum*. Usually the affection does not cause much inconvenience, though itching and burning sensations are at times complained of by the patient.

Hallopeau[2] regards the xanthomatous growths as benign neoplasms of embryonic origin, and shares the view of Touton, that they owe their origin to the generative embryonic fat-cells which persist in the tissues and proliferate. Hallopeau is of opinion that the jaundice which frequently is present in this disease may be due to the presence of these cells in the biliary passages, and thinks it not improbable that the glycosuria which exists in those exceedingly rare cases known as *xanthoma diabeticorum*, may be due to these cells being located in the pancreas.

Treatment.—Recently electrolysis has been employed in the removal of the lesions; this method is preferable to the use of the knife.

Angeioma.

Sodium ethylate, applied by means of a glass rod, is regarded by some as a very good remedy in cases of angeioma.

Lymphangeioma.

Synonyms: *Lymphangiectasis; Lupus lymphaticus; Lymphangeioma cavernosum; Pachydermia lymphorrhagica.*

Prognosis.—It would appear from the scant literature on the subject that this affection does not tend to disappear spontaneously, and that the growth has reappeared even after it had been removed with the knife.

[1] See reports of two cases of extensive xanthoma multiplex; the one by George Thomas Jackson, Journal of Cutaneous and Genito-Urinary Diseases, 1890, vol. viii., p. 241; the other by E. J. Stout, ibid., June, 1894.

[2] Annales de Derm. et de Syph., 1893, tome iv., p. 935.

Rhinoscleroma.

Bacilli have been found in the lesions of rhinoscleroma; these organisms are rod-shaped, their length exceeds their breadth by one and one-half times, they have rounded ends and are enclosed in a capsule, and they occur in free groups, or in cells. In appearance they are very similar to the pneumococci of Friedländer; some authors regard these organisms as the etiological factor of the disease, and think that their presence causes the lymphatics to become blocked. Others consider the infiltrated condition as being closely allied to the granulation tumors which occur in such diseases as leprosy, syphilis, etc.

Treatment.—Salicylic acid has given encouraging results in Lang's hands; this remedy was employed both internally, in the dose of 10 grains three times daily, during a long period, and externally in the form of hypodermic injections, of one-per-cent. strength, repeated daily. Douches of sodium salicylate were used in the naso-pharynx, and solutions of the drug in alcohol were applied to the diseased mucous membranes.

Lupus Erythematosus.

Synonyms: *Seborrhœa congestiva; Lupus superficialis; Lupus erythematodes; Lupus sebaceus; Lupus non-exedens.* French, *Scrofulide erythémateuse; Erythème centrifuge.*

Four varieties of this affection have been described: the circumscribed or discoid, the telangiectasic, the nodular, and the diffuse or disseminated. Some authors regard lupus erythematosus as a species of cutaneous tuberculosis; it has a tendency to occur in scrofulous individuals.

Treatment.—Iodine, arsenic, and potassium iodide may be given internally. McCall Anderson recommends the administration of iodide of starch in heaped teaspoonful doses, in water or gruel, given three times daily. Bulkley advocates $\frac{1}{50}$ to $\frac{1}{30}$ grain doses of phosphorus thrice daily. Strict attention should be paid to hygienic conditions and to the general health. Locally the use of Paquelin's cautery, applied lightly to the diseased areas, is regarded very favorably by some writers. Scarification with the multiple scarifier, making longitudinal and transverse incisions, about $\frac{1}{16}$ in. apart, may be employed. Before operating, local anæsthesia may be produced with the rhigolene or ether spray; the application of absorbent cotton and pressure will readily check the hemorrhage. The operation may be repeated after the wounds have healed. This method is followed by very slight scarring and is highly recommended. Electrolysis has also proved useful.

Lupus Vulgaris.

Some investigators consider this a local manifestation of tuberculosis. In America the coexistence of phthisis and lupus has been but rarely observed. The disease is undoubtedly at times due to direct inoculation. Experimental inoculations with lupoid material, introduced into

the abdominal cavities of guinea-pigs, have given rise to general tuberculosis in these animals.

Morbid Anatomy.—Koch has succeeded in finding bacilli in lupoid tissue, which cannot be differentiated from the bacilli of tuberculosis. The reaction following the injection of tuberculin in lupus patients also points to lupus as being a cutaneous tuberculosis.

Treatment.—Applications of salicylic acid, in the strength of 10 to 20 per cent., on plaster, are a good remedy; creasote is advantageously combined with the acid, equal parts of each, for the purpose of decreasing the pain. Bichloride of mercury in solution, gr. 1 to 2 to the ounce, or in ointment form, of the same strength, is reported to act very beneficially. Injections of tuberculin have proved too dangerous, and the results obtained too temporary, to justify their use.

Dr. George Fox removes small nodules with dental burrs and the excavator. Scarification with the multiple scarifier is a very good method of treatment. A multiple scarifier devised by Van Harlingen[1] will be found very useful in this operation. The incisions are to be made longitudinally and transversely and should extend through the diseased area to the sound tissues. Bésnier advocates the use of electrocautery knives of different sizes. Electrolysis in multiple punctures, or by means of a metallic button, may also be employed.

LEPROSY.

In the treatment of leprosy segregation and isolation of the affected individuals must be rigidly enforced in order to prevent the spread of the disease.

CONNECTIVE-TISSUE CANCER.

This constitutes the so-called cancer *en cuirasse* of Velpeau; when this condition exists, the chest movements are interfered with and respiration becomes difficult.

MADURA FOOT.

Synonyms: *Ulcus grave; Tubercular disease of the foot; Podelcoma; Mycetoma.*

Usually only one foot is attacked, and at times only parts of a hand or foot are affected. In very rare cases the shoulders and scrotum are the seat of the disease. The palmar surface of the finger or thumb, and the plantar surface of the toe or the spaces between the toes, are the locations in which the disease often makes its first appearance. The affection has been attributed to the presence of a splinter or thorn in the foot, or to a slight traumatism; in a number of cases dracunculosis has been observed to have been followed by podelcoma. The possibility of the fungus penetrating through the skin in individuals who are accustomed to go barefoot in wet, low ground, has been mentioned by

[1] Handbook of Skin Diseases, p. 298.

writers who have had occasion to observe the disease in India. Very often we are completely at a loss to account for the origin of the affection. Two observers, Carter and Crookshank, have arrived at the conclusion that the clinical as well as pathological conditions existing in mycetoma are analogous to those observed in actinomycosis, and are of the opinion that the disease should be considered as actinomycosis occurring in the human race. Two varieties of the disease have been observed, known respectively as the pale or yellow, and the black; the latter variety occurs most frequently.

Treatment.—When the disease is still confined to the superficial layers, and has not been of long duration, the affected area should be thoroughly curetted and an appropriate dressing applied.

Parasitic Diseases.

Favus. — Synonyms: *Honeycomb Ringworm; Porrigo lupinosa; Porrigo favosa; Tinea lupinosa; Crusted Ringworm.* German, *Erbgrind.* French, *Teigne faveuse.*—This disease is due to the presence of a fungus known as the *achorion Schoenleinii.* Remak, in 1836, first called attention to the fungoid character of the crusts; three years later Schoenlein established their fungoid nature beyond a doubt. In England the disease is decidedly rare, but it is often met with in Scotland; it is of frequent occurrence in France, and is very common in Poland and Italy. In the United States favus is rare, but is not infrequently seen among the lower classes of recently arrived immigrants, and a case occurring in the head of a child eight years of age, of American parents, and supposed to have been contracted in a barber-shop, has recently come under my notice. Although usually located on the scalp, favus may attack any part of the surface, and even the mucous membranes. Epidermic favus is regarded as rare, although quite extensive cases of that character have been recorded by Kaposi, Roddick, E. J. Stout, myself, and others.[1] Authors have described several varieties of favus fungus. Three forms have been spoken of by Unna, to which he has given the name of favus griseus, favus sulphureus tardus, and favus sulphureus celerior. Quincke has also differentiated three varieties of the fungus, which he has named respectively α, β, and γ fungus. The majority of authors, however, are of the opinion that there exists but one achorion fungus.

It appears that favus, in common with other vegetable parasitic affections, shows a disposition to attack certain individuals in preference to others; thus it would seem that certain soils are peculiarly favorable to its propagation.

Treatment.—The employment of poultices or hot applications is to be deprecated in the treatment of this affection, as it is a well-known fact that moist heat is favorable to the growth of the fungus.

The treatment formerly in vogue, known as the "calotte," or pitch cap, has been abandoned, being very severe and even dangerous to life. Bulkley advocates the use of epilating sticks, which consist of: ℞ Ceræ flavæ, ʒ iij; Laccæ in tabulis, ʒ iv; Resinæ, ʒ vi; Picis burgundicæ, ʒ xi; Gummi dammar, ℥ iss. These sticks are from two to three inches

[1] Journal of Cutaneous and Genito-Urinary Diseases, September, 1894.

in length, and from one-fourth to three-fourths of an inch in diameter. After the hair has been clipped quite short, the stick is heated and applied to the scalp, and after remaining in contact with the scalp until quite cold, it is removed with a rotary motion. Numerous hair-stumps and adhering fungous growth will be found clinging to the stick.

ONYCHOMYCOSIS.—Favus of the nail (*Tinea favosa unguium*) is a decidedly rare affection; in almost every case the fungus is introduced under the nails by scratching the scalp affected with favus. The *treatment* is tedious. The nail should be rendered quite thin by filing, and a parasiticide should then be used. Removal of the nail and application of a parasiticide to the affected area is the quickest method of effecting a cure, although this process is decidedly heroic.

TINEA TONSURANS.—A good method of treating this affection, based on the fact of the fungus being aërobic, consists in combining a suitable parasiticide with collodion. This excludes the air and does not allow the fungus to develop. Thus corrosive sublimate, in the strength of from ½ grain to 4 grains to the ounce of collodion, or salicylic acid ten grains to the ounce, should be applied daily with a camel's-hair brush to and around the patches. At the expiration of one week the crust formed by the collodion should be removed with forceps, when large numbers of hair-stumps will be found adhering to it. This process is repeated in the same manner at the end of a week. In cases of short duration, occurring among older children, Coster's paste may be used with advantage. The formula is as follows: ℞ Iodi, ʒij; Olei picis, ʒi (the ingredients should be slowly and carefully mixed). This solution is applied to the patches with a brush. It is advisable to remove the crusts which form with forceps, as more fungi and diseased hairs stick to the crust when pulled off in this manner than when allowed to drop off themselves. The parts are then rubbed well with sapo viridis and flannel, and the remedy is reapplied. Dr. James Foulis recommends the following treatment: A towel is tied around the child's head so as to protect the eyes; the hair is cut quite short in the vicinity of the lesions, or when a number of lesions exist the entire hair should be clipped. Oil of turpentine is then freely applied to the affected area and rubbed in well with the finger. This removes the scales and dirt, and after a few minutes penetrates quite deeply. The head is then thoroughly washed with 10 per cent. carbolic acid soap and warm water, which relieves the smarting caused by the turpentine. After drying the head well with a towel, several applications of tincture of iodine are made to the affected areas, and after the parts have become dry, the entire scalp is rubbed with carbolized oil (1 to 20), which destroys any spores that may exist. Foulis states that this treatment, used every morning, or morning and night in obstinate cases, is followed by cure in a week.

TINEA VERSICOLOR.—Synonyms: *Chromophytosis; Dermatomycosis furfuracea; Mycosis microsporina.* German, *Kleienflechte.* — In Biart's case[1] patches of the disease were found on the left cheek; the forehead was also affected and the scalp slightly; a spot was also dis-

[1] Amer. Jour. Cutan. and Vener. Diseases, vol. iii., 1885, p. 43.

covered behind the ear. Payne has observed the presence of the parasite on the scalp and beard. I have quite frequently observed the disease in married couples, in whom it was confined to one individual alone. Experimental inoculations have been successfully practised by Köbner, who has managed to inoculate men and also rabbits with the disease.

Treatment.—Hyposulphite of sodium, ʒi to the ounce of water, applied night and morning, is a very good remedy. The applications should be preceded by a warm bath and the free use of soap, which will enable the remedy to penetrate more readily. The use of tincture of iodine in cases which are not extensive is also followed by good and quick results.

SCABIES.—The strength of the remedies employed in the treatment of scabies must be graded according to the age of the patient, and the sensitiveness and general condition of the skin. The following ointment is a very useful one: ℞ β Naphthol, Sulph. sublim., āā ʒi; Adipis, ʒi. This salve is to be thoroughly rubbed into the affected parts with the hands night and morning, and its use is to be continued for three or four days. At the expiration of that time a bath is taken, and the underclothing and bed-linen are changed. Should signs of the disease still exist after three or four days the same treatment is repeated. Owing to its non-irritating and non-toxic properties oxynaphthoic acid, a remedy recommended by Schwimmer, can be used advantageously upon children. The formula is as follows: ℞ Acidi oxynaphthoici, Pulv. cretæ, Saponis viridis, āā ℈iv; Adipis, q. s. ad ʒi. M.

PEDICULOSIS CAPITIS.[1]—The color of the head-louse is usually grayish or ashy, but is said to vary according to the color of the individual on whom it is found; thus it is black on the negro, white on the Eskimo, and yellowish-brown on the Chinese. The ova or "nits" are attached to the hair by means of a glutinous material, called chitin. The pediculus capitis gains its nutriment by inserting its haustellum, or proboscis, into a cutaneous follicle to reach a small vessel. Lice do not bite.

The condition known as plica polonica, or Weichselzopf, presents a frightful picture of aggravated lousiness. In appearance the pediculus capitis is very similar though smaller than the pediculus corporis. Male lice are not as large and are less numerous than the female.

Treatment.—The following application will be found very useful. ℞ Extract staphisagriæ fld., f ʒi; Acidi acetic. dil., f ʒiij. Sig. Apply thoroughly to the scalp. The stavesacre destroys the lice and the dilute acetic acid the ova. Naphthol used in the form of oil, or soap, is also a good remedy.

PEDICULOSIS CORPORIS.—The pediculus corporis procures its nutriment by means of a haustellum or sucking apparatus, consisting of a membranous tube, which it inserts into the follicles of the skin.

Treatment.—The application of Extr. staphisagriæ fld., f ʒi–ij; Adipis, ʒi, to the affected area, will be followed by the destruction of the parasites that may be found on the skin.

[1] Lice belong to the order rynchotta.

PEDICULOSIS PUBIS.—Sometimes the parasite is met with on the whiskers and beard, and on the hairy part of the chest. The female louse is nearly twice as large as the male.

Treatment.—A very cleanly method consists in applying lint saturated with chloroform and covering it with oiled silk. This kills the parasite quickly; to remove the remaining ova, vinegar answers well. Bichloride of mercury, in the strength of 1 grain to the ounce of vinegar, destroys both the pediculi and ova. It should never be forgotten that the mercurials, especially when numerous excoriations or abrasions are present, may be absorbed and produce salivation. Mercurial ointment, quite a popular remedy, is uncleanly and should be dispensed with.

PSOROSPERMOSIS.—Synonyms: *Keratosis follicularis* (White); *Ichthyosis sebacea cornea* (E. Wilson); *Acne sebacea cornea; Proliferative follicular psorospermosis; General hypertrophy of the sebaceous system* (Lutz); *Darier's disease; Psorospermose folliculaire végétante* (Darier); *Ichthyosis follicularis.*—This is a disease of the skin, of unknown etiology, commencing on the face or trunk, but ultimately spreading to other portions of the body, and characterized by the development of papules of small size and of a dirty-red color, with firmly adherent and grayish, brown, or black, horny crusts which may be squeezed out of the papules by the thumb-nails.

Etiology.—Darier, who was the first to accurately describe the affection in 1889, and other dermatologists who followed him, supposed that the disease was due to certain unicellular, oviform parasites, the psorosperms or coccidiæ. More recent investigators, however, have proved that these supposed psorosperms were in reality nothing more than altered epithelial cells. It is possible that there may be an hereditary factor present in the disease; the true etiology is still, however, merely a matter of conjecture.

Symptoms.—1. *The papular stage.* The disease nearly always starts upon the face, but in time involves the adjacent parts, and then spreads to the trunk; it especially affects the axillary and inguinal regions. The cutaneous lesions are at first papillary, each papule being pin-head in size and dull-red in color; it is capped by a dark gray, brown, or black crust, which, if removed, leaves a funnel-shaped depression. At the outset there are but a few of these discrete lesions, but with the progress of the disease they increase rapidly in number, and may even become confluent in places; such patches are covered with a large brownish and oily-looking crust, with a rough and irregular surface.

2. *The papillomatous or vegetating stage.* Each papule, late in the disease, takes on a renewed growth and becomes excessively developed; marked elevations of the skin are thus produced, and these may be surmounted by horny crusts one-quarter to three-quarters of an inch in length. These papillomatous masses are most frequently found in the hypogastric and inguinal regions and around the arms. They are very apt to show spots of superficial ulceration, especially in the neighborhood of the orifices of the hair follicles; when this occurs the discharge is very fetid and sero-purulent in nature. The ulcerated spots are sensitive, and by preventing sleep and locomotion tend greatly to reduce the patient's strength and vitality. When the disease attacks

the scalp it gives an appearance closely resembling that produced by seborrhœa sicca, with the exception that the hairs do not show a tendency to fall as in that disease. The parts of the face most liable to attack are the creases around the nostrils and lips, the temples, and the inner surface of the concha of the ear. The course of the disease is slow as a rule, with, however, occasional acute exacerbations, during which considerable areas may rapidly become involved. The eruption is developed symmetrically in its usual sites.

Pathology.—According to Bowen, Robinson, and other dermatologists, the change in the skin consists in a "keratinization of the epithelial lining of the ducts of the pilo-sebaceous conduit." This hardening of the tissues, as it progresses, gives rise to the formation of the horny masses. Between the stratum granulosum and the rete are developed numerous small roundish bodies containing what are supposed to be nuclei and nucleoli; these are the so-called psorosperms. The pathology is by no means accurately determined as yet, a sufficient number of cases not having been reported.

Diagnosis.—From molluscum contagiosum it may be distinguished by its greater generalization, and by the absence of the characteristic enucleable mass of the latter disease, containing the molluscous bodies. Then, too, the base of the papule is pearly white in molluscum contagiosum, while it is dirty-red in color in the disease in question. In the later stage the two diseases are quite distinct. From pityriasis rubra pilaris it may be distinguished by the presence in that disease of the typical, isolated, scale-capped papule pierced by the hairy filament.

Prognosis.—This is bad as regards a cure. The disease progresses steadily, and seems to be but little influenced by medication. As a rule, the general health is not seriously affected.

Treatment.—This should consist of cleanliness, with shampooings and soft-soap inunctions, followed by the application of drying and absorbing dusting powders, such as boric or salicylic acid. If the parasitic theory of the causation of the disease be accepted, parasiticides should be employed. These would include salves of iodoform or dermatol, baths of sulphide of potassium and other sulphur-containing waters, and in advanced cases cauterization with chloride of zinc.

DISEASES OF THE CELLULAR TISSUE.

BY

SAMUEL ASHHURST, M.D.,

SURGEON TO THE CHILDREN'S HOSPITAL, PHILADELPHIA.

THE paper of the late Professor Howe[1] needs but little amendment, since the annals of surgical science do not contain much to add to the essay as it came from his pen. The task of the present writer will be chiefly to indicate the modifications of treatment which have received the general approbation of practical surgeons since the original paper appeared, and which consist mainly of alterations brought about by the universal adoption and more thorough application of the principles of aseptic surgery.

Modern investigation has, however, made some advances which have an important bearing upon the theory which seeks an explanation or elucidation of the causes of disease in the cellular tissue. By these investigations, made by means of improved microscopical methods, we have learned to look upon the all-including areolar tissue of the body as something more than a framework to support and unite other organs. There is good reason to think that the all-pervading cellular tissue, by its connection with the lymphatic system, is itself an organ of the highest value, having functions of a most important and vital kind—a circumstance which throws much light upon its pathology. The same investigations point to the fact as very highly probable, if not yet conclusively demonstrated, that in the areolar interspaces begin the mouths of the lymphatics, if these interspaces are not those mouths themselves.

If this histological inference should prove to be correct, and it is supported by many observations, it will go far to account for the various inflammations which have their seat in the cellular tissue. Foreign and injurious matter, whether from without or from the detritus of the various organs, seeking admission to the circulation, is arrested primarily in the areolar interspaces and afterward extends through the primary lymphatic trunks to the nearest collection of lymphatic vessels or glands. According to its character it excites more or less irritation in the vessels through which it passes, at the first gland it reaches, or in the cellular interspace—that is, lymphatic mouth—by which it finds admission to the general system. Modern observation tends to confirm the doctrine that upon the character of the materies morbi thus admitted depend the various kinds and grades of areolar inflammation, rather than upon any local peculiarities of the areolar tissue itself.

[1] See Vol. III., page 117.

Thus continued study of bacteriology may enable us to speak positively as to the modifying influence exerted by this or that microscopic germ upon different kinds of pus, and to account for the varieties observed. There would seem to be little doubt that these varieties are accompanied by different kinds of spores, and when repeated observations have proved the connection between them to be more than accidental, we shall have gained a point from which we may begin to differentiate the varieties of areolar disease dependent thereupon. But at present we are not able to do more than frame hypothetical structures in accordance with the dim teachings of observations thus far made. Everything points to the important sphere which the bacteriologist is to occupy; and it is upon what is to be learned from his cultures that the development of our exact knowledge concerning varieties of areolar disease in large measure depends.

It would also seem as if much information might be obtained from a larger and more accurate knowledge of the parasites infesting all animal structures. With his advancing years the late Dr. Joseph Leidy devoted more and more attention to parasites, but without reference to the diseased conditions brought about by their presence. No member of the animal kingdom was brought to him that he did not detect many, and often new, varieties of parasites. The writer recalls the fact that in an ordinary ocean sun-fish Professor Leidy showed him no less than five parasites which he had detected in those few tissues that he had examined, and no less than two of them had been previously undescribed. Dr. Howe describes three of the forms which are known to cause disturbance in the connective tissue of man, but even a moderate acquaintance with parasites might lead us to a better understanding of those which in their process of entry, growth, or death, cause diseases which we term inflammatory, but of the true etiology of which we are entirely ignorant at the present time.

Adhering to the divisions made by Dr. Howe, it will be the aim of the present writer merely to make such additional observations upon each as seem to him to be called for or made necessary by the rapid progress of surgical science.

Simple Cellulitis.—This is of frequent occurrence, and the importance of searching for and removing the cause should not be lost sight of, as upon it the treatment must largely depend. This will generally lie along the lines laid down by Dr. Howe. As a general thing local pressure will be found advantageous in the treatment of cellulitis, and the use of such dressings only as are found by experience to be unirritating. Yet moderately strong solutions of sugar of lead will generally be found beneficial, either alone or combined with laudanum, lead from its well-known sedative qualities being less irritating than the other astringents. When suppuration occurs, the free incisions advised by Dr. Howe should be immediately resorted to, and here compression, together with proper drainage and the use of aseptic lotions, will help to secure sound healing of the parts.

Both pressure and drainage act as preventives of that entrance of the "exudates" into the circulation which modern surgeons have learned to dread, while the comfort to be obtained from a properly applied bandage either of cotton or flannel is a matter of daily experience. As a

general thing that which is really comfortable to the patient, and not merely pronounced so from the fear of interference, is good for him. Experience has taught the writer the advantage of blowing both hot and cold in such cases as do not require the use of the knife. He has very often seen marked advantage from the use of a counter-irritant, such as the tincture of iodine, followed immediately by a poultice or warm-water dressing, while he must also bear his testimony to the good effects secured by either the simple or the compound iodine ointment as an aid to resolution. The same is true of belladonna and mercurial ointments, either alone or in combination in chronic cases.

Where repeated attacks of cellulitis occur without any traumatic cause, some vice of constitution underlies it, and alkalies, colchicum, or mercury, may be needed according as rheumatism, gout, or syphilis is at the bottom of the trouble.

PERI-VENOUS CELLULITIS.—Of *peri-venous cellulitis* there is nothing to be added to what has already been so well said by Professor Howe.

While the inflammation is primarily and chiefly outside the neighboring veins, it is somewhat difficult to say positively that there is not a true phlebitis also present, as shown by the presence of more or less adherent thrombi and by the softened condition of the walls of the veins. Yet the distinction as drawn by Dr. Howe should be borne in mind, and the treatment which he recommends in these cases should be carefully followed. In free stimulation lies the only hope of the patient, and should systemic poisoning ensue, either from breaking down of the clots contained in the veins, or from without by means of septic matter entering through their open channels, the issue will hardly differ from that to be expected in true septicæmia.

PERI-ARTHRITIC CELLULITIS.—The interesting and important question in *peri-arthritic cellulitis* is to discriminate between disease within and without the joints. In the vigorous it is attended with little danger to life, but in those possessing vitiated constitutions, either young or old, the drain upon the vital powers may easily exceed their ability to endure. Ordinarily, however, the fact that the suppuration lies outside the joint will bring relief to the mind of the surgeon, who may therefore quite safely commit himself to a favorable prognosis, with the assurance that no permanent injury to limb or danger to life need be anticipated. To satisfy himself on this point, therefore, the surgeon will do well to spare no pains in seeking to arrive at a correct diagnosis by carefully following out the rules clearly if succinctly laid down by Dr. Howe. Prompt opening of the abscess or abscesses, with good drainage, absolute rest for a time by the use of splints, and the use of a supporting diet, are the indications for treatment.

ISCHIO-RECTAL CELLULITIS.—This is very common, and its importance as a cause of fistula in ano is generally recognized. This comes not from peculiarities in the inflammation itself, nor from those of the areolar tissue in which it is situated. The trouble lies in the anatomy of the region, in which the mouth of a tube, through which so often very irritating matters pass, is surrounded by a sphincter and other

muscles, the constant contraction of which interferes with union between the walls of any abscess. Sometimes, yet often enough to make the attempt worth while, the very early and free incision of an abscess, causing its entire emptying, and the accurate apposition of its walls, with perfect quiet, may prevent the formation of a sinus, and secure union without destroying the integrity of the sphincter; but generally no such desirable result is obtained, and a fistula is formed. Indeed, so rare is such a union that when it is necessary to open an ischio-rectal abscess it becomes a question whether the muscle should not be divided at once, and further trouble and pain thereby be avoided. The immediate division of the muscle is a trivial addition to the incision and packing of the abscess required, and the certainty of securing prompt and sound union is thereby so great that the writer has many times adopted it as the regular treatment of the abscess, and has never had occasion to regret it. The advice of Dr. Howe concerning the opening of fistulous tracks is good, but as a general thing the abscess is a very simple affair at first, and when freely opened and then put at rest by a division of the sphincter, there is little danger of burrowing of pus and the consequent formation of a series of such tracks. Even should there be no communication of the abscess with the bowel, it is better at once to divide the sphincter, as thereby an open wound is secured, to the healing of which there is no impediment, while there is no likelihood of incontinence of fæces following. It is not generally necessary to extend the incision up the wall of the bowel to the highest point of the abscess, as healing will generally follow, especially in recent cases, when the incision merely includes the sphincter and the wall of the rectum covering it.

PERI-PHALANGEAL CELLULITIS.—In the few graphic words with which he depicts *peri-phalangeal cellulitis* Dr. Howe does not in the least exaggerate the suffering experienced in connection with it, rarely, indeed, exceeded by that induced by any other surgical affection. Nor will any practical surgeon question the correctness of the advice given by him. Yet experience teaches that the prompt use of the knife, and it should be used without reference to the presence of pus, is not in every case attended by the relief looked for. Occasionally the pain persists and the periosteal irritation extends despite the free use of the bistoury. When this state of things exists, we can only make free and repeated incisions to favor the escape of matter, and prevent burrowing by the use of fine drainage-tubes, horsehairs, or catgut.

PERI-CÆCAL CELLULITIS.—This is an affection which has attracted more and more attention of late years, and the remarks made by Dr. Howe are in some degree prophetic, indicating the treatment which has become the established one, and foreshadowing that exploration of the abdominal cavity in cases of acute peritonitis which, however desperate a measure in the eyes of our predecessors, has been resorted to of late years as one which can hardly increase the perilous condition of the patient, while giving him one more chance of life. Dr. Howe was familiar with the inflammation produced by the appendix vermiformis, but he did not know that its removal as a useless and often dangerous organ would become the fashion.

When cellulitis depends upon impaction of fæces in the cæcum the use of purgatives is very clearly indicated, but in the experience of the writer they should be used cautiously and frequently, rather than actively, nothing in his experience being equal to repeated and small doses of calomel, with or without opium according to circumstances, continued for some time. This treatment combined with hot fomentations will often obviate a resort to the use of the knife, but if pus has once formed, its prompt evacuation by operation is imperative. The operation is often attended by most satisfactory results, and may be undertaken without the dread of wounding the peritoneum once so prevalent among surgeons, as nature has generally glued the parts together as a preliminary to the exit of pus. The condition of the appendix vermiformis is a question which intrudes itself into every case of perityphlitis, and in cutting down to evacuate matter in this region no surgeon would nowadays rest until he had informed himself as to the state of that organ, the question of the removal of which is considered elsewhere.

PAINFUL HYPERTROPHY OF THE AREOLAR TISSUE.—In the American Journal of the Medical Sciences for November, 1892 (page 521), Dr. F. X. Dercum narrates a case of what he terms "adiposis dolorosa," and similar cases are recorded by the same gentleman and by Dr. F. P. Henry in the University Medical Magazine for December, 1888, and in the Journal of Nervous and Mental Disease for March, 1891, all of the cases having points of resemblance to myxœdema. There was a great increase of the connective and adipose tissues over greater or less areas, together with painful symptoms indicative of fugitive and irregular irritation of nerve trunks, possibly a neuritis. The cases were unaffected by treatment and eventually ended unfavorably, the patients dying from long-continued suffering and exhaustion.

INJURIES OF BLOOD-VESSELS AND ANEURISM.

BY

LOUIS McLANE TIFFANY, M.D.,

PROFESSOR OF SURGERY IN THE UNIVERSITY OF MARYLAND, BALTIMORE, MD.

INJURIES OF BLOOD-VESSELS.

IN the ten years that have elapsed since the article on "Injuries of Blood-Vessels"[1] was written, little has been recognized which can in any wise improve upon or modify the masterly exposition of the subject presented by Dr. Lidell. His philosophic reasoning and discussion remain now, as formerly, in the first rank of surgical writing. In the matter of treatment, however, a revolution has taken place, which has been brought about through the agency of those principles first enunciated by Lister, and now recognized and practised throughout the civilized world. What I shall say, therefore, refers to the effect which the presence or absence of suppuration has to do with wounded vessels. The occurrence of secondary hemorrhage, the methods for its arrest, the methods of arresting primary hemorrhage, in order that such arrest shall be definitive, is really nothing more or less than a consideration of whether the operator is able to close the wounded vessel in an aseptic way, whence there is to be expected recovery without complication. On the other hand, torsion, acupressure, the use of ligatures of one kind or another—metal, animal, or vegetable—constriction by crushing, aërteriversion, cauterization, and the employment of chemical hæmostatics, are simply gropings after a method for the arrest of hemorrhage without having suppuration as a necessary sequence—a method which we now are very largely able to understand and practise.

The application of an aseptic ligature in an aseptic wound secures definitive closure of the vessel and recovery without complication. The ligature to be used for the closure of a vessel is subject somewhat to the fancy of the surgeon, silk and catgut being the preference of most operators. Perhaps as time goes on, silk is more often the choice than catgut; and, if clean, it gives no trouble. It can always be obtained pure, and is not absorbed before the ligated vessel is definitively closed. The same will be said of catgut by those who prefer it. The method, however, of obtaining clean silk is so simple as to be at the disposition of every one. Heat, that absolute destroyer of all life, will render silk sterile, and at the same time not materially impair its strength, so that

[1] See vol. II., page 495.

it is always at hand, and in that respect leaves little to be desired. Steam heat kept up for forty or fifty minutes prepares silk for any emergency. Catgut, properly prepared, is doubtless quite as efficacious. My own preference is for silk. I use it always and have no complaint to make.

Perhaps the first and most important advantage which is brought about by aseptic operation is the absence of suppuration; the ligatures applied to vessels remain and are not cast out. One end of the ligature is not allowed to hang out of the wound for the purpose of withdrawal, but the wound is closed and nothing ever is seen of the ligatures, which, being cut short, remain permanently.

The method by which the definitive closure of an artery is brought about when ligated is described differently by different observers. It appears certain, however, that, while in applying the ligature the internal and middle coats are easily bruised and perhaps divided, such bruising and division are not necessary. What is necessary is that the internal surfaces of the artery should be pressed together and the lumen thus closed. Great stress was formerly laid on the necessity for dividing by ligature the two internal coats—a necessity now known not to exist.

Again, it is a point about which there is difference of opinion as to whether a proximal thrombus is necessarily present in an artery after ligation. As a matter of fact, it usually is, and while it may not be necessary as an essential factor of the obliteration of the vessel, yet it does by its presence diminish the shock of the blood against the point ligated, and furnishes a medium in which the blood-vessels may proliferate and assist definitive and permanent closure of the vessel, and a framework for granulation tissue. It is probable that the extent of the traumatism enters as an immediate factor into the size of the thrombus, and it is probable, also, that the presence of sepsis influences unfavorably the organization of the thrombus, as it unquestionably does the exudation surrounding the ligated point. In this connection it is worth noting that Warren calls attention to the presence of clots in the hypogastric arteries of newly born infants; and in certainly one instance found a clot of large size in the obliterated ductus arteriosus of a young child—a place from which both trauma and sepsis could be excluded. In veins there appears to be no doubt that the presence of a clot is not necessary to insure definitive closure after a wound; the lateral ligature of the vein wall shows this, the lumen of the vessel being restored by immediate union of the opposed surfaces; and in the same way a fine lateral suture of the wounded vein wall is followed by permanent closure. Hence the presence of a proximal thrombus is to be considered in relation to arteries only. It is proper to consider the method by which a ligated artery is closed definitively, in much the same way that one is accustomed to consider the formation of callus in relation to a broken bone. A vessel tied without much disturbance of, or interference with, surrounding parts heals with a minimum of callus (clot), whereas if there is much injury to soft parts and much denudation of the vessel wall the amount of callus is increased. Investigators are not in accord as to how this callus is formed: whether it be by immediate union of proliferating cells from the intima, by the exit of wandering cells from the vessels, by proliferation of connective-tissue cells, or

by proliferation of muscle cells from the media, does not seem yet to be settled, and it is not worth while to discuss the matter here; but in the absence of sepsis, a clean ligature applied to the vessel aseptically, results in definitive closure of that vessel at the point tied, without suppuration, the ligature remaining encysted and never being heard from. The disturbance of surrounding parts when an artery is ligated, and the necessity at one time thought to exist for very limited denudation, need not be considered, provided that there is absence of sepsis. The evil influence of suppuration on the process of cicatrization of blood-vessels cannot be too earnestly insisted on. Failure to obtain definitive closure of a vessel is not seen in clean wounds; and the many deaths recorded as resulting from secondary hemorrhage are mainly evidences of failure to preserve wounds aseptic. Of course it is a fact that, in a certain number of cases, a vessel after having been once injured may give way without the supervention of suppuration, but such cases are rare. Again, when it is recognized that a surgeon has usually in his hands the power of preventing secondary hemorrhage and the evil effects of suppuration on vessels by prompt and cleanly action, it is all the more necessary for him to exercise such power.

ANEURISM.

During the time that has elapsed since the article on aneurism was published,[1] the changes which have come to pass are those mainly due to the recognition of the advantages directly resulting from aseptic methods in operating, and the unhappy state of affairs which would follow if such a method of operating were not recognized and followed out; and the treatment of aneurism has accordingly been much modified. The methods of flexion and compression in aneurisms of the extremities, are much less made use of at present than in times past, owing to the comparative safety of the ligature and the good results which may be expected confidently to result therefrom. Indeed, it is proper to say that when an aneurism is recognized, the question will present itself at once to the surgeon's mind, "Is there any reason why ligation should not be done?" and if not proper, then other methods may be had recourse to. Atheroma of an artery, or a diseased arterial wall from other cause, scarcely seems to be a sufficient reason why ligation should not be practised, provided that it is done in such a way as to avoid the occurrence of inflammation.

The application of a ligature, then, to an artery on the proximal side of an aneurism, and the almost certain closure of the same without trouble, has done away with the necessity for employing other methods of treatment so well explained and described in the original article of Mr. Barwell. The material to be used for ligatures can be appreciated by referring to the preceding section on Injuries of the Blood-Vessels.

Secondary hemorrhage after ligation for aneurism is now not to be expected, at least from the point where the ligature is applied; but other complications resulting from the persistence of the sac of the aneurism, containing more or less blood and coagulum, still remain to endanger the otherwise excellent outcome resulting from the ligation—

[1] See Vol. II., page 825.

suppuration of the sac and gangrene of the extremity, both of which occurrences have been noted not infrequently; and while aseptic ligation of the vessel relieves the operating surgeon from one anxiety, the danger resulting from the other still remains; consequently much attention has been given, of late years, to the removal of the sac.

The good results which follow aseptic ligation of a vessel have emboldened surgeons to try, and the result of experience seems to justify, the extirpation of the aneurismal sac, ligatures being placed on the main vessel at points proximal and distal to the dilatation, the aneurism itself being considered and treated as a tumor to be removed in its entirety, leaving a simple connective-tissue wound, which will heal as the wound remaining after the removal of a tumor of any other kind. It is only necessary to look into the records of cases to see how often otherwise successful treatment of an aneurism has been rendered nugatory by the behavior of the sac; the contained blood failing to organize, and so becoming a suppurating focus and entailing the loss of what would otherwise have been a useful limb. I cannot avoid thinking that it is a very great advantage in the surgical treatment of aneurism to extirpate the sac. The fear that the vessel close to the aneurism, both above and below, will not bear ligature, is obviated by aseptic operating; and it is without doubt a fact, that the removal of the tumor, by relieving tension in the limb and pressure on the veins, renders the occurrence of gangrene less likely. An atheromatous artery will unquestionably resist sepsis and suppuration less well than a healthy artery, but sepsis and suppuration should not occur; hence it is to be expected that a ligature applied very close to the sac, if done in a clean way, will be followed by definitive closure of the vessel.

Wherefore it becomes proper in extirpating an aneurism to tie the main vessel close to the sac above and below. If the ligature is applied at a distance, as in the Hunterian method, there occurs, when the patient recovers, an obliteration of the vessel at the point ligated, and also where the aneurism exists, two places some distance apart. By tying the vessel above and below the aneurism, close to the sac, there is definitive closure at but one place and not two, and the danger of gangrene would seem thus to be diminished.

Just what vessels may or may not be properly subjected to this operation, we are as yet not in a condition to know, since the operation is of too recent a date for one to speak of it dogmatically, but so perfect has the result been in my own hands that I am inclined to think it should be made use of wherever possible.

There are many difficulties inherent to this treatment—the irregularity of the sac, close adhesion of adjacent and important structures, irregular protrusion of the sac in one direction or another, making its removal not easy—which at first sight may seem to militate against it; but these difficulties are physical ones, and the skill of the surgeon will overcome them. No other insuperable objections at this time present themselves to my mind. Should a portion of the sac be indissolubly united and incorporated with important structures, and so incapable of removal, it might have to be left, but I imagine that such a condition of affairs would be very exceptional. Should a dilatation of the artery exist in that part of the vessel where large branches are given off, it would be proper, in removing the sac, that those branches should

be tied just as would the main vessel. The best method of removing a sac is more or less uncertain, and will have to be decided by the special case. Of course the most simple and easy way is to remove it without opening it, as any other tumor is removed, the first ligature being applied on the proximal side of the sac, which is then shelled out toward the distal end, and the vessel then again tied. Another method would be the application of ligatures above and below the sac, which should then be split and dissected out; or it might be expedient to begin at the distal extremity of the sac and dissect upward; but no rule can be given which would apply to every case. In the case of a burst aneurism, the extravasated blood should be removed by curette or otherwise, according as might seem proper, but at all events the operator should take away the foreign body from the limb and so give rest to adjacent and important structures, as well as relieve pressure, which would unquestionably interfere with the restoration of the circulation in the limb, the main artery of which had been tied.

In traumatic aneurism there is no possible doubt about the fact that the indications are to freely expose and tie the vessel above and below the seat of injury, removing the coagulum entirely if possible, and thus placing the limb in the best possible condition to recover. This is now and always has been accepted as the best treatment, and needs no discussion.

In order to extirpate an aneurism it is necessary to thoroughly uncover it by external incisions, to freely open and incise overlying parts, whether soft tissue or bone—the clavicle, for instance, in axillary or subclavian aneurism. The sac is not to be pulled and roughly treated, but is to be removed by dissection, and the surgeon in this operation, as in removing deep tumors elsewhere in the body, is to work with the edge of his knife well in sight, retractors being employed to draw aside adjacent structures.

SURGICAL DISEASES OF THE VASCULAR SYSTEM.

BY

JOHN A. WYETH, M.D.,

OF NEW YORK.

ASSISTED BY

W. W. VANARSDALE, M.D.

PHLEBITIS.

Two things have united to extend our knowledge of the pathology of the venous system since the appearance of the first volumes of the present work: the recent great advances in bacteriology; and the part played by the blood-plates in effecting thrombosis, the study of which is intimately connected with that of phlebitis.

We may, for the better elucidation of the subject, divide phlebitis into *infectious phlebitis*, an inflammatory condition due to the presence of micro-organisms in the tissues involved; and *simple hyperplastic phlebitis*, characterized by an infiltration of the tissues with new cells and a proliferation of their structural elements—a type of inflammation of low grade and mainly reparative in character.

Either form of phlebitis may be associated with the occurrence of thrombosis within the vein (thrombo-phlebitis)—or it may be due to the advancement of inflammatory conditions from the immediate vicinity of the vein (*periphlebitis*)—an advancement which is the more readily accomplished, as the adventitia of many veins is practically continuous with the surrounding connective tissue.

I shall first consider *simple proliferating thrombo-phlebitis*.

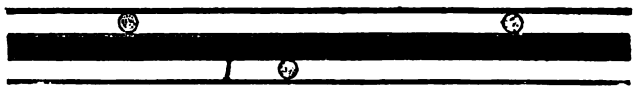
The question whether thrombosis is the primary condition and phlebitis the consecutive one (as represented by Rindfleisch, Ziegler, and others), or whether this order should be reversed (Dupuytren, Cornil and Ranvier), is still one in regard to which unanimity has not been reached. But it now appears probable that some injury to the endothelium is the primary exciting cause of phlebitis, which on the one hand, under certain conditions, leads to the formation of a thrombus within the vein, and simultaneously gives rise to hyperplastic changes in the vein-walls (Weigert).

Thrombosis is, therefore, now believed to take place only when injuries to the endothelial lining of the vessels are associated with a stagnation

or a slackening of the velocity of the blood-current. With stagnation a red thrombus is formed; with a slackened arrest a white or a mixed one.

This latter process, the formation of a mixed thrombus, is now known to be brought about by means of the blood-plates, or *plâques* (Kemp),

Fig. 1606.

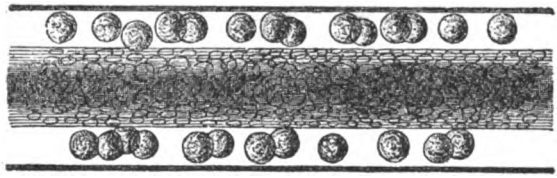


Normal Rapid Blood-Currents, Axial in Character. (Eberth and Schimmelbusch.)

the third corpuscles of the blood, first described by Donné (Osler), and identical with the hæmatoblasts of Hayem.

If a small vein in the mesentery of an animal be watched under the microscope (Bizzozero, Eberth and Schimmelbush, Loewit), and the blood-current retain its normal velocity, a red homogeneous streak will be observed occupying the centre of the lumen of the vessel, being the appearance produced by the blood-corpuscles in rapid motion. On

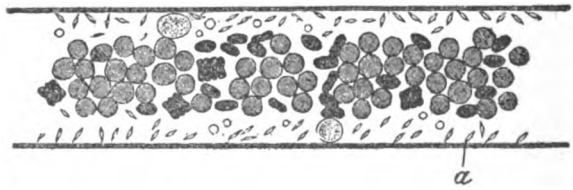
Fig. 1607.



Marginal Position of White Blood-Corpuscles: the Current Slower. (Eberth and Schimmelbusch.)

either side of this streak, between it and the wall of the vessel, as seen through the microscope, may be observed a transparent zone of plasma, in which but one or two white blood-corpuscles appear, as they slowly roll along the walls (Fig. 1606). If the blood-current be now caused to move somewhat more slowly, the red blood-discs may be discerned more plainly, and the white corpuscles are observed attaching themselves to the vessel-walls in greater numbers (Fig. 1607). And if the current

Fig. 1608.



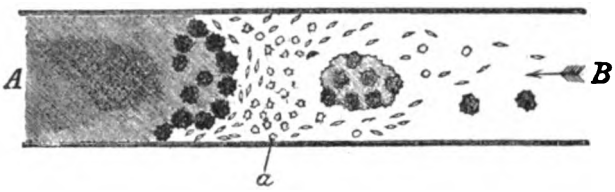
Current Still Slower: Fewer White Corpuscles. *a*, Blood-plates in plasmatic zone. (Eberth and Schimmelbusch.)

be still more retarded, so that the shape of the red blood-corpuscles may be distinctly viewed, the leucocytes again become fewer, and among them, in the plasmatic zone and close to the vessel-wall, appear the little blood-plates (Fig. 1608, *a*) in great numbers; and if there be any injury done to the wall of the vessel, these platelets immediately collect

at the injured point, adhering tightly to the vessel-wall and to each other. Sooner or later the leucocytes also take part in this accumulation, provided that the force of the current is not sufficient to carry them away; and red corpuscles may also be imprisoned in the mass, in case the conditions of the current are favorable.

The accumulated blood-plates are said to undergo a change of consistency at the time that they attach themselves to the seat of injury (Fig. 1609); they become very adhesive (the viscous metamorphosis and conglutination of Eberth), and undergo a fine granular change, after

Fig. 1609.



Stagnation of Blood-Current. *A*, Red hyaline thrombus; *B*, communication with vessel in which current continues; *a*, blood-plates. (Eberth and Schimmelbusch.)

which they appear split up into fine threads; and, possibly, are afterward transformed into hyaline substance (Aschoff).

Simultaneously with the appearance of leucocytes, fibrin is seen in the clot; but whether this fibrin-formation is due to the blood-plates alone, or to the presence of the leucocytes, has not yet been satisfactorily established.

The theory of A. Schmidt, referred to in Vol. III., p. 327, has of late years become somewhat modified in consequence of the general acceptance of the above views.

The fibrin-ferment, the liberation of which is believed to precipitate the coagulation of the blood, is said to emanate from the blood-plates at the time when they become massed together; although some authors (Hauser) hold that any living cell may set free fibrin-ferment on its disintegration. Again, Gürber has shown that it is not necessary that leucocytes should perish in order that fibrin be formed; and Mosen has demonstrated that masses of pure plates collected from the blood by centrifugation, when coagulated, present unmistakable fibrin-formation. Salvioli, indeed, maintains, that by extraction of all blood-plates from a living animal (which he achieves by repeated blood-letting and re-infusion) coagulation of the blood is rendered impossible.

On the other hand Pekelharing and Lilienfeld, who have studied the chemical aspect of coagulation of blood, still hold the leucocytes principally responsible for the formation of fibrin-ferment. The former found that fibrin-ferment was an organic calcium-compound (calcium-nucleol albumin) which was formed, most generally, when leucocytes were destroyed. The latter considers the nuclei of the leucocytes to be composed of leuco-nucleïn and histon (a kind of peptone). Nucleïn (a proteïn containing phosphorus) causes coagulation; histon prevents it. But calcium chloride combines with histon, setting nucleïn free, and thus causes coagulation. Lilienfeld, moreover, regards the blood-plates as identical with the nuclei of the leucocytes, set free by karyoschisis. If corroborated, these theories will explain many incongruous tenets in vogue at the present time.

Conformably with this description of the formation of a white thrombus, the microscopical examination of a clot reveals a ramified frame-structure resembling a (red) coral-growth, composed of accumulated

blood-plates (Aschoff), which appears as an irregular network in any given section of a clot, and is the cause of its "streaked" appearance. In the interstices fibrin threads are seen radiating from the framework, and, in addition, red and white blood-corpuscles (Weigert), the latter of which probably to some extent actively penetrate into the thrombus after its formation (Welch).

The further fate of such a thrombus, provided that it remains *in situ*, and is not invaded by pyogenic micro-organisms, is this: it contracts, and finally undergoes the same changes as do the vessel-walls; by which, on the one hand, so-called organization of the clot (by which is meant substitution by connective tissue) takes place, and on the other hand phlebitis is established.

This latter consists in the infiltration of all the layers of the vessel-wall with leucocytes and so-called fibroblasts (spindle-shaped, often ramified, nucleated cells, somewhat larger than the leucocytes), derived, most probably, from the endothelia and the external coats. At the same time new vessels are formed, which advance toward the thrombus itself, originating from the small vasa vasorum supplying the vessel-walls.

The establishment of this form of phlebitis, through the medium of lesions to the endothelium combined with a diminished rapidity of the blood-current, with thrombus formation, may be traced to any of the following primary causes: irregularities of the inner surface of the vein, such as contractures or unevennesses due to localized dilatations, causing eddies and irregularities in the blood-current; local lesions of

Fig. 1610.

Blood-Plate Thrombus. (Eberth and Schimmelbusch.)

the vessel-walls, chemical, mechanical, or thermal; intoxications by chemical agents; and, lastly, general impairment of health (Aschoff).

Very similar to the infiltration and hyperplasia of the vein-walls associated with thrombosis, is that form of inflammation of the veins consequent upon *periphlebitis*, with only this difference, that in the latter case the thickening of the adventitia is more marked, at least in the earlier stages of the process (Ebeling).

The final result of all these simpler forms of phlebitis, in extreme cases, is the substitution of cicatricial tissue for the entire venous tunics (the same fate that befalls the blood clot), so that in those cases where the process is entirely completed nothing remains after the lapse of several months but a fibrous cord.

In case the thrombus becomes partly detached and deprived of its nutrition to a great extent, it is apt to undergo calcareous degeneration and petrify, and in this manner the so-called vein-stones or phleboliths are formed.

In case organization of the thrombus does not take place, the clot

may undergo simple (red) softening, and be carried away as molecular detritus by the blood-stream.

An entirely different process, however, from those above described, may be observed the moment pyogenic germs gain access to the vein-walls. If the invasion occurs from without (as in infected wounds), the first condition encountered is a *purulent periphlebitis*. This condition may extend along the course of the vein and external to it, giving rise to the reddened and indurated cords clinically characteristic of this disorder. As soon, however, as the invasion of pyogenic micro-organisms extends through the vessel-walls to the intima, conditions of far greater severity are at once established: necrosis with suppurative inflammation is produced, and thrombosis takes place in the lumen. But the thrombus thus formed does not undergo organization and absorption as in the uninfected forms of thrombo-phlebitis: it likewise becomes invaded by the pyogenic micro-organisms, and in due course of time becomes disintegrated by bacterial action. It melts to a yellow, puriform mass, and is subsequently swept away by the blood current, and bearing, as it does, numberless active and virulent germs among its particles, gives rise to numerous infectious emboli in the capillaries of remote organs and causes irreparable mischief.

These inundations of the system by infectious material are clinically characterized by severe rigors, and go to make up the clinical picture of pyæmia. During the progress of this disease such emboli may also, in their turn, be the exciting cause of thrombo-phlebitis.

Finally, mention may here be made of a morbid condition of the veins, which may be properly classified under the heading phlebitis, although all writers do not consider it an inflammatory process. I refer to *phlebosclerosis*, a disease recently described more minutely by Sack, and bearing analogy to arteriosclerosis, but one which hardly ever attains the same development or the same importance as the arterial lesion. Phlebosclerosis consists in a fibrous thickening of the inner coat of the vein (endophlebitis). The thickening may be either diffuse or circumscribed, and is accordingly designated as *phlebosclerosis nodosa* or *diffusa*. The newly formed tissue lies in the intima, and consists of connective tissue, which, however, soon undergoes degeneration, generally hyaline in character, and then may again become disintegrated into fatty and granular detritus, or may calcify (atheroma). The tunica media and tunica adventitia, however, are not unaffected in the later stages of phlebosclerosis, both foci of infiltration with small round cells and recent or cicatrized areas of connective tissue, in which degeneration, hyaline or fatty in character, has taken place, being observed here.

The primary cause of these conditions is a weakening of the muscular tone and contractile power of the media, by which secondary compensating changes, consisting in the proliferation of the tissues (chronic phlebitis), are induced at first in the intima.

Of the varieties of phlebitis other than those described, some forms are ascribed to constitutional disturbances—*gouty phlebitis*, *rheumatic phlebitis* (Schmitt). But the greater part are recognized as due to specific infectious agents (tuberculosis, glanders, actinomycosis, and, probably, syphilis and acute articular rheumatism).

Tubercular phlebitis, described by Weigert and Muegge, induces infiltration of the vein-walls with round cells and proliferation of the tis-

sues, with consequent cicatrization or coagulation-necrosis and cheesy degeneration. If this process progresses so far as to affect the intima, ulceration may take place into the lumen of the vessel, in which case cheesy material, accompanied by the tubercle bacilli, is introduced into the blood-current, inundating the entire system and establishing general acute miliary tuberculosis.

Very similar in its pathology is the *phlebitis of glanders*, which frequently causes a generalization of the disease by means of infected thrombi (Israel).

In *traumatic phlebitis* exactly the same conditions obtain as were described under the head of simple proliferating thrombo-phlebitis, provided the injury done to the veins is of an aseptic character. After aseptic ligature of the veins, no thrombus is formed, unless an injury of the endothelium is associated with a reduced velocity of the blood-current. Obliteration of the vein is completed by newly formed tissue in a comparatively short time, in about five days, on the average.

If septic conditions are permitted to complicate the wounds, the vein-walls and the thrombus behave in the manner described on page 0257 in speaking of periphlebitis and purulent thrombo-phlebitis.

ARTERITIS.

The subject of *traumatic arteritis* has been one of unabated interest and continued research since the first volumes of the present work appeared in print, and deligation of arteries in animals has been practised to the present time by various observers as a simple and efficient method of inquiry into the difficult problems associated with this theme. Not, however, until comparatively recently has much attention been given to the influence of antisepsis and asepsis upon the facts under discussion. This now appears as a point of great importance, although some writers deem it of only secondary interest or advisedly dismiss it from view as immaterial.

We now know that the pathological changes in an artery after traumatism vary considerably with the immediate effect of such traumatism upon the blood-current.

If the blood-current in an artery be not intercepted for any length of time, as in the cases where ligatures have been tightly applied to the arteries and then immediately removed (Zahn), or where sutures have been laterally applied to the arterial walls after incisions, etc., repair to the injured portions progresses toward restitution without the formation of any appreciable clot whatever. Only in those cases in which a slowing of the current occurs, or is artificially maintained for a time (Jassinowski), do clots appear, and these consist solely of aggregated masses of blood-plates (white thrombus).

If, on the other hand, deligation of the artery is carried out with sufficient force to interrupt the blood-current, the formation of a blood-clot is dependent upon the fate of the endothelial lining of the artery. If this retains its vitality no clot is formed; if it loses its vitality a red thrombus is formed of the stagnant blood in the immediate vicinity of the ligature, and reaching, on its proximal side, to the next lateral branch, however small or microscopic in size this may be.

Now, generally speaking, deligation of an artery is practised in such a manner that the inner coat of the artery is injured or ruptured; and in these cases we have the formation of a (red) thrombus and definite occlusion of the vessel by substitution of this thrombus by newly formed tissue.

But it is possible to tie the ligature about an artery in such a manner that no laceration of the inner coat is produced; and it is now sufficiently well established experimentally, that aseptically conducted deligation of arteries does not necessarily cause the death of the endothelium (Weigert). In such cases we have occlusion of the vessel by proliferating endarteritis alone, as well as by the immigration of leucocytes from the nearest vasa vasorum, without the formation of a clot (Landerer).

We may, therefore, sum up our present knowledge in the proposition, that clotting takes place only when damage to the endothelium is associated with a too rapid current, and that, generally speaking, the size of the blood-clot is in inverse proportion to the asepticity of the procedure.

It must not be imagined, however, that unanimity in these questions has been arrived at by all experimenters. Many results differing from the above have been recorded in the literature of this subject (Ballance and Edmunds, Delépine and Dent, Arnaud, etc.), which for the present must be ascribed to variations of technique. The effects of atrophic changes in the endothelia due to ligature-pressure, upon the formation of a clot, likewise require more elucidation.

Repair or definitive occlusion after an injury to an artery, without the formation of a clot, then, begins by the proliferation of the single layer of cells of the endothelium, which embryologically belongs to the connective-tissue group (His), with karyokinesis. This occurred, in the cases observed by Pick, on the fifth day. In this manner buds and spurs were formed projecting into the lumen of the artery (eighth day); flat and spindle cells appeared in great numbers, all showing mitoses, which now occurred also in the media and in the adventitia as well. Infiltration with round cells, however, was mostly limited to the outer coat. By the eighth day the blood, hitherto unchanged in the lumen of the vessel, began to undergo granular disintegration. Karyokinesis continued with unabated vigor till after the twentieth day, when the lumen was almost entirely filled with proliferated elements of the intima.

In those cases, on the other hand, in which a clot is formed after ligation of an artery, from the causes mentioned above, the definitive obliteration of the vessel progresses simultaneously with the substitution of the clot by newly formed tissue.

On this point all writers are agreed. But until recently there has been much discussion on the more minute histological processes involved in this transformation.

While one school of pathologists believed that the leucocytes enclosed in the thrombus led to its organization (Virchow, Weber), others attributed the tissue-change to the white blood-corpuscles emigrated from the vasa vasorum (Cohnheim, Ziegler), and still others held that the tissue substituting the thrombus originated by proliferation from the cells of the intima (Waldeyer, Thiersch).

Of late, however, Apollonio appears to have adjusted these discrepancies more satisfactorily. Examining a large number of arterial ligations in animals by means of series of sections, and staining the mitoses, he found that in various portions or sections of the ligated arteries entirely different tissue-elements took part in the organization of the thrombus, as well as in the repair of the arterial walls. In the neighborhood of the ligature, atrophy of the vessel-walls took place, and regeneration and organization of the clot was effected by leucocytes. In sections more removed from the ligature, however, but occurring in the same artery, where the intima adjoining the portion undergoing atrophy was stimulated to proliferation, the organization of this part of the clot was due to the proliferation of the intima. The conclusion drawn from these observations is that any histological element capable of proliferation may take an active part in the organization of a blood-clot, a conclusion which not only at once unites all the dissenting views of numerous accurate observers, but one which is substantiated in some particulars by observations less generally accepted. Thus Warren declared that muscle-elements could take part in the organization of the thrombus, a point which had once been maintained but was afterward again abandoned by Zahn.

The remarks made thus far pertain to traumatic arteritis in healthy tissues only, and it is apparent that the process encountered, of infiltration and proliferation with new vessel-formation and cicatrization, is more characteristic of the course of repair, than of inflammation proper. With the neglect, however, of precautions to preserve the field of experimentation free from infections or chemical irritations, more serious inflammatory reaction may be observed; and suppuration and necrosis may be induced through the introduction of a *contagium vivum* into the wound.

In such forms of traumatic arteritis of a septic nature, greater numbers of emigrated leucocytes are found, with copious fluid extravasation, gelatinous in character and not spontaneously coagulable. Here, too, reproduction of tissue elements takes place. The wall of the artery presents a cloudy appearance, assumes a brownish-yellow color, loses its consistency, and finally, being permeated by immense numbers of round cells, melts, and is dissolved into pus, or succumbs to necrosis in irregular shreds and particles. The thrombus shares the same fate; it is turned to a yellow or brownish pulpy mass through the action of micro-organisms, and may become more or less putrid. Embolism of virulent septic matter may occur through the melting of the thrombus, or secondary hemorrhage may be caused by the sudden yielding of an occluding clot in the lumen of an artery.

Septic emboli may reproduce this picture of septic arteritis in remote vessels.

Perfectly analogous to the forms of traumatic arteritis just described, are the other forms of arteritis of non-traumatic origin, and this analogy has become more marked with the tendency to assume some damage to the tissue as the immediate cause of inflammatory conditions in the economy.

In this way not only the simpler idiopathic forms of acute arteritis are viewed at the present time, but also those chronic changes which affect principally the internal coats, and are classed in many handbooks

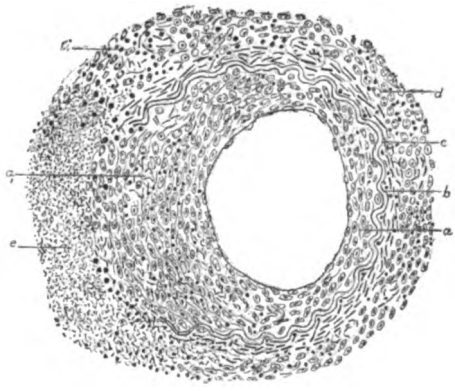
on pathology, not as inflammatory but as degenerative processes: I refer to arterio-sclerosis and atheroma.

Simple hyperplastic arteritis is observed in connection with thrombosis (when some damage to the endothelium has been associated with a slowing of the blood-current), and consists in an infiltration of all the coats of the vessel-walls, both with round cells extravasated from the vasa vasorum and from neighboring vessels, and with spindle-shaped or digitated nucleated cells, so-called fibroblasts, emanating from the endothelial and peripheral connective tissue. New vessels are also formed, and push inward into the thrombus. In time new connective tissue is produced by which the thrombus is replaced. After a long interval of time the intima alone appears thickened and hyperplastic.

Arterio-sclerosis, in its first stage, is now considered as a reactive inflammatory proliferation of the tissues of the intima, due to damage done to the walls of the vessel. Such damage may be caused by simple senile weakening of the tissues, as well as by chronic pathological conditions, such as chronic nephritis; the results of infections, as acute articular rheumatism, endocarditis, typhoid fever; or chronic poisoning with alcohol, lead or mercury, and syphilis.

Thoma has pointed out that the muscle-elements of the media were the first to suffer damage, and that this impaired the elasticity and led to a functional deficiency of the media, which was compensated by hyperplastic changes in the intima. Tissue-proliferation and inflammatory areas are, nevertheless, frequently found outside of the intima, in the media and adventitia, as well as at the primary seat of damage.

Fig. 1611.



Tuberculous Arteritis. (Ziegler.)

At a comparatively early period, however, the newly formed connective tissue undergoes hyaline degeneration, with granular and fatty metamorphosis, mucin-formation, or calcification, and in areas of complete necrosis masses of fatty detritus result, which may open by ulceration into the lumen of the artery. Atheroma is said by Thoma to originate from the necrosed, newly formed connective tissue, having first undergone hyaline degeneration.

If these simpler forms of arteritis just described may be considered analogous to simple traumatic arteritis, we might look for a further analogy to the septic suppurative form of traumatic arteritis in the remaining undescribed forms of infectious arteritis, such as the syphilitic and the tuberculous (Fig. 1611).

The analogy, however, is only one of etiology, and, for a description of arterial syphilis the reader is referred to Vol. III. of the present work; while the remarks made on tuberculosis of the veins on page 0257 apply as well to that of arteries.

VARIX.

In spite of the large number of new studies that are added each year to the extensive literature of varicose veins, our knowledge as to the morbid condition which is the primary cause of varix-formation advances but slowly. The proliferation of tissue which causes the veins to become longer than is normal, and therefore to appear tortuous and serpentine, still remains an obscure factor in the pathology of the disorder. Another factor, on the contrary, that of dilatation of the lumen and changes of thickness in the walls of the veins, has received considerable elucidation by the work of Epstein, which has more recently been corroborated by Sack.

It now appears that two conditions must be in force simultaneously in order that varices be formed; first, increased local blood-pressure and embarrassment of the return circulation, and, second, some specific pathological condition as yet not satisfactorily defined.

Von Lesser could not induce varicosities in animals by increasing the blood-pressure alone with the help of injections of plaster-of-Paris, and was therefore led to assume that the process active in the formation of varices was analogous to the growth of a tumor; and he believed this theory confirmed by the discovery, made by means of injections, that varicose veins were most generally situated superficially to the lymphatics, and were therefore, in most cases, simply enlarged veins of the skin.

Epstein made a special study of ectatic veins, and found that the cirsoid and varicose phlebectasiæ of the lower extremities showed anatomical changes in all the coats of the vessel-walls.

The tunica media generally shows an eccentric hypertrophy, which in great degrees of dilatation becomes an eccentric atrophy of the muscularis; oftentimes, however, atrophy of the muscular coat may be observed with only moderate dilatation of the lumen of the vein. The media and adventitia present increased vascularization and a varying infiltration with small round cells, while in the intima fibrous endophlebitis occurs, evidently compensatory in character, and analogous to phlebo-sclerosis. Epstein, therefore, believes that the primary cause of varix is the decreased resistance in the middle or muscular tunic, and considers the mechanical factors merely secondary in importance.

In accordance with these views he sketches the course of the development of varicose veins as follows: (1) loss of resistance in the tunica media; (2) dilatation of the lumen; (3) compensatory endophlebitis; (4) eccentric hypertrophy; (5) (in cases of greater dilatation) eccentric atrophy. The infiltration in the outer tunics is of the character of reparative inflammation.

The predisposing causes of varix formation are general disorders of nutrition, and similar to those of phlebo-sclerosis (see page 0257). Bennett, who in addition to the element of pressure is fain to accept some factor at present unknown to us, ascribes the formation of varicosities in some cases to congenital defects in the venous apparatus, and even attributes these to hereditary influences. This element of heredity is brought forward by other writers as well (Fischer); and Soboroff has

shown that the histological structure of the veins differs as to thickness and strength in various individuals from their birth.

If we accept the foregoing views, we are led to consider the treatment of varicose veins from two main standpoints. If the formation of varix is due to the combination of continued augmented pressure with a morbid condition of the vein-walls, we will not expect a radical cure from the elimination of only one of the factors which go to make up the disorder, but will endeavor to combine a systemic treatment with some proceeding, palliative or operative, to eliminate the local discrepancy in equal distribution of pressure. And, in point of fact, we know by long experience that most methods aiming at a radical cure, which have only attacked the one factor of undue pressure, have proved futile, in that a recurrence after a longer or shorter interval has been observed, about two years on the average.

Notwithstanding these theoretical conclusions, we find a great increase in the number of operative measures employed for the radical cure of varicose veins, keeping pace with the advances in antiseptic and aseptic methods.

The procedures most generally favored at the present time are multiple ligations, subcutaneous (Schede, C. Phelps) or open (Bennett), of the varicose veins; excisions of more or less extensive portions of the diseased veins (Madelung); and the ligation of the trunk of the saphena (Trendelenburg). The latter method is advised only for cases where the saphenous trunk is enlarged as well as its branches.

A new palliative method has been devised by Landerer, who occludes the enlarged veins by means of pressure exercised by parabolic springs with pads filled with water, worn around the leg after the manner of a truss.

INJURIES AND SURGICAL DISEASES OF THE LYMPHATICS.

BY

CHARLES B. NANCREDE, A.M., M.D.,

PROFESSOR OF SURGERY AND OF CLINICAL SURGERY IN THE UNIVERSITY OF MICHIGAN; EMERITUS PROFESSOR OF GENERAL AND ORTHOPÆDIC SURGERY IN THE PHILADELPHIA POLYCLINIC, ETC.

General Considerations.

THE superficial lymph-plexuses are so numerous, and are so situated, that poisonous antiseptic solutions must be employed with caution when applied for long periods to extended skin surfaces; for a similar reason the external application of germicidal substances beneficially influences the course of some varieties of lymphangeitis. Again, very slight friction—even none that can be appreciated—may cause the penetration of organisms into the superficial lymphatics, giving rise to so-called dissection and post-mortem wounds, where in reality no solution of continuity exists. There can be no doubt of this fact, since the cutaneous form of erysipelas, that is, a reticular lymphangeitis, has been produced by rubbing pure cultures of the streptococcus into the unabraded skin, while, clinically, such cases as that of Sir James Paget's occur from time to time.

Exception must be taken to the statement of Mr. Bellamy, that the "outpoured lymph" from a wound "becomes ultimately developed into the bond of union whereby reparation of the injured tissue chiefly comes about,"[1] since modern investigation certainly has long since shown that the coagulable lymph of wounds is not the same as the lymph in the lymph-vessels, but that the proliferated cells of the two sides of the wound, fusing, become vascularized and develop into scar tissue.

Traumatic Affections of Lymphatcs.

TRAUMATIC LYMPH-CYSTS.—This is the condition described by Morel-Lavallée as a "traumatic serous effusion," and is believed by Gussenbauer and Köhler to result from subcutaneous rupture of lymphatic vessels. These soft, rounded, ill-defined tumors contain a fluid identical with lymph.

[1] Vol. III., p. 27.

TRAUMATIC LYMPH FISTULÆ.—These occur chiefly in the neighborhood of joints, as at the fold of the elbow, on the inner side of the thigh, near the ankle in front of the malleoli, and in the neck. Wounds are more apt to be followed by fistulæ when pre-existing lymphatic dilatation is present. S. Georgjovic, analyzing 28 cases of wounds of lymphatic trunks, found that 5 involved the thoracic duct, 6 followed bleeding, 2 resulted from opening buboes, 9 followed incisions or punctures, while the remaining 6 were caused by the opening of abscesses or the removal of tumors.

Treatment.—Antiseptic tamponnade, or digital pressure, suffices for recent cases. Leudesdorf obtained a success by maintaining digital compression for eight hours. When failure follows compression applied chiefly below the fistula—as is commonly recommended—direct pressure over the fistulous opening should be tried, remembering, however, that in some cases this method produces retention of lymph, œdema, and repeated abscesses. In old cases the use of iodine, caustics, or the hot iron, to destroy the indurated margins of the fistula, may have to precede and supplement pressure.

RUPTURE OF THE THORACIC DUCT.—Divesting the report of all details not pertinent to our present purposes, the following is a typical case of the fatal result which too often follows from this accident, while it proves the correctness of Mr. Bellamy's statement that death is often postponed for a long time:—

A man, aged 28, had his thorax violently compressed. On the seventeenth day a fluctuating swelling was detected in the inguinal region, which gave vent, upon incision, to offensive gas and a fæcal-like fluid; but in a few days all odor ceased, and the discharge became milky in appearance. Such rapid emaciation ensued (four pounds daily), that twenty-two days subsequently—that is, on the 38th day from the accident—the man died of inanition. After death it was found [the point of interest for my present purposes] that a cavity, formed by dissecting up the right pleura posteriorly, extended from the apex of the thorax to the diaphragm, and contained a similar milky fluid to that which had escaped from the fistula during life; an opening was detected in the thoracic duct where it passed through the aortic opening in the diaphragm, thus explaining the two routes pursued by the chylous extravasation.[1]

Of the seventeen cases in Kirchner's list, the cause of injury was twice contusion of the chest; once each, puncture, incision, and shot-wound; thrice ulceration following suppuration, while in the remaining nine the cause was not made clear. Chylothorax resulted in nine cases, chylous ascites in six, one was a doubtful instance of mediastinal extravasation, and the remaining one was due to an operation wound inflicted near the terminal portion of the duct.

Symptoms.—These depend upon the location and extent of the extravasation; thus a patient of Krabbel's died on the 5th day from compression of the lung by an extensive chylothorax; one of Kirchner's patients developed an increasing dyspnœa from a pleural effusion, which upon aspiration proved to be chyle, improvement, followed by recovery, taking place. Rapid emaciation and death from inanition must sooner or later supervene unless the opening becomes occluded, or unless a double duct, or a variation in the method of formation of the duct, admits of a

[1] Alvin Eyer, Med. Record, Aug. 1, 1891.

collateral lymph circulation becoming established. Small experimental wounds in animals have been found to heal, the same result being of course possible in the human being.

Treatment.—I have seen in consultation two cases of chylous ascites caused by the pressure of enlarged lymphatic glands which probably led to rupture of the receptaculum chyli or a large lymph trunk, though in neither, at the post-mortem examination, could any opening into a lymphatic vessel be demonstrated. One patient died after repeated tappings from exhaustion, and the other from the same cause after an apparently successful abdominal section with drainage, all chylous fluid having soon ceased to flow, doubtless owing to occlusion of the leaking vessel by plastic peritonitis. The operation was done with this end in view, and, as far as one case goes, suggests the propriety of abdominal section with antiseptic packing and drainage under similar circumstances.

TREATMENT OF WOUNDS OF LARGE LYMPHATIC TRUNKS.—With our present knowledge of the germicidal power of carbolic acid, but still more on account of its irritant effects, the advice to apply pressure "by a suitable compress, . . . soaked in a lotion of carbolic acid (1 to 40)" should be substituted by the recommendation to employ a thoroughly *aseptic pad* after dusting with aseptic iodoform or the interposition between the wound and compress of some protective whenever carbolic acid, corrosive sublimate, or other poisonous germicide is used. Four cases of accidental wound of the thoracic duct, inflicted while removing cervical tumors, have been collected by Keen.[1] These show what should be done in the way of *treatment:* one patient recovered after immediate antiseptic *tamponnade* of the wound, and another after the application of pressure-forceps for three days to the tissues forming the external orifice of the fistula (a secondary operation). Keen detected a wound one-fourth of an inch long in a tube one-eighth of an inch in diameter, and sewed it up with fine silk, employing drainage for a few hours and then closing the wound. The patient returned home in eight days.

LYMPHANGEITIS.

The division into simple and septic lymphangeitis may be an excellent one clinically, but the idea implied that one occurs without the presence of germs, and that the other results from the action of micro-organisms, is incorrect. All forms of lymphangeitis, even the most typical reticular variety,[2] result from the presence in the lymph vessels of some one of the pyogenic organisms. The "wandering" form of Curnow, or what Rosenbach has described as "erysipeloid," has been shown by the latter to be due to the invasion of the superficial lymphatic plexuses by a specific thread-forming, spore-producing micro-organism which is derived from decomposing animal matter. The presence of micro-organisms in the lymphatics induces the formation of clots, which usually incompletely block the lumina of these vessels.

[1] New York Med. Jour., vol. lix., pp. 569–572.

[2] F. Fischer and E. Levy, Verhandl. Deutsch. Gesellsch. f. Chirurg., XX. Congress, 1892 (Annals of Surgery, vol. xv., p. 488).

The entire absence of any such thrombus has beeen suggested as a cause of the rapid spread in certain hyper-acute cases, a clot acting for a time as an obstacle to the further progress of the disease.

The possibility of infected lymphatic emboli becoming a cause of secondary pyæmic deposits must not be overlooked. The same germs which initiated the primary suppurative focus are found enclosed in the lymph-thrombus. The endothelial lining of the vessels has been described as completely preserved,[1] or as at first thickened, then desquamating in patches, and finally disappearing throughout the extent of the diseased portion of vessel.[2] The vessel-walls are thickened from infiltration with round-cells, and a similar slighter infiltration is detectable around the capillaries. When suppuration occurs, the usual changes take place both in the thrombus, in the altered wall, and in the perivascular infiltrate. In all "lymphatic abscesses" micro-organisms are invariably found, the suppuration resulting from either a simple or a "mixed infection," when more than one form of germ is present; the bacillus coli communis even has been detected as the sole pyogenic organism.

Superficial wounds involving the complex plexuses of the deeper epidermic layers, those of the true derm or the subcutaneous tissues, are most apt to give rise to lymphangeitis. Although nearly always following a wound, lymphangeitis may occur without any visible lesion of the skin, but Verneuil contends that this results from the "interstitial auto-infection" produced by germs present in the uninjured skin (Staphylococcus epidermidis albus of Welch?). Still further, Jouet[3] points out that sometimes many days or weeks after cicatrization of the wound which gave entrance to the infective organisms, a lymphangeitis may commence, going on to enlargement of the neighboring glands or even to suppuration (*lymphangites tardives*). Simple lymphangeitis may also occur around *neoplasms*, the avenues for the entrance of the ordinary micro-organisms being afforded by lesions of the tumor, the inflammation resulting from these and not from infection by the tumor elements.

Skin diseases frequently give rise to attacks of lymphangeitis, but this affection rarely originates in any but one of the suppurative forms.

The *environment* and the *habits* of the patient exercise a marked influence upon the initiation of the disease, and upon the supervention of the graver accidents, such as suppuration or gangrene.

Diabetes is supposed to exercise much influence in this direction, but it is very doubtful whether this disease especially predisposes to inflammation of the lymphatics. *Chronic alcoholism* and *overwork* certainly appear to favor the occurrence of the graver forms.

Unfavorable *hygienic surroundings* such as overcrowding, dampness, insufficient food, overwork, and lack of cleanliness unquestionably explain how overlooked or trivial abrasions may be sufficient to give entrance to micro-organisms in such numbers of cases, commencing at or about the same time, as to give rise to the idea that lymphangeitis may be epidemic.[4] What has already been said will serve as introduction to the following paragraphs.

The differing results from the same poison are to be explained by the

[1] Ibid. [2] Duplay et Reclus, Traité de Chirurgie, tome i., p. 651.
[3] Ibid., p. 649.
[4] Ibid., p. 650.

condition of the tissues[1]: thus, if of normal vitality, they can certainly resist a considerable number of germs; if their vitality be lowered, but few of the same germs are requisite to produce serious consequences; of course, given an enormous dose of germs, no condition of tissues howsoever healthy can inhibit their development. The time at which a dead body can convey an infective and therefore dangerous form of lymphangeitis, is before putrefaction is well established—that is, the more recent the death the greater the danger—because the infective germs thrive and multiply only in living tissues, while the septic germs can develop only in dead or dying tissues; hence the introduction of the latter into an ordinary dissecting or post-mortem wound can only produce a local irritation from the accompanying ptomaines; the germs themselves cannot multiply in the living tissues.

The slow development of septic lymphangeitis results not from "the slow nature of the lymphatic circulation," but because the germs require a certain time for their diffusion along the lymph-vessels, for their multiplication to the point at which their numbers are adequate to overcome the vitality of the parts, and for a sufficient amount of ptomaines or toxalbumoses to have been elaborated to produce the constitutional reaction.

Certain rare cases exist, such as one mentioned by Berthod, where the point of infection is at the elbow, and yet the lymphangeitis descends, and suppuration occurs in the forearm; Berthod explains this on the anatomical ground of the presence of recurrent lymph-vessels.[2]

The rapidity with which a septic lymphangeitis may develop is shown by a case of Hunter's, mentioned by Crookshank, where, after a puncture, redness extending to the axilla, swollen and painful glands, with a chill, all occurred inside of a few minutes. Weber[3] relates a similar case, and I have myself seen one where the axillary lymphatic engorgement was so great within about three hours as to cause marked tingling and numbness in the median and ulnar nerve distribution. The *rôle* played by lymphangeitis in plegmonous processes, whether circumscribed, diffused, or visceral, can hardly be exaggerated, since cellulitis of an extremity is always consecutive to lymphangeitis, the connective tissue being infected by two routes—(1) indirectly, by the lymphatic vessels, and (2) by the direct inoculation of the connective tissue (that is, lymph-spaces) by germs deposited in these by the vulnerating body. According to Cornil and Babes, at the first spot in which the bacteria multiply there occurs softening of the surrounding tissue, an irritation marked by a neuro-paralytic dilatation of the capillaries and by diapedesis of lymph-cells, constituting already a small abscess (this is where direct inoculation of the connective tissue has occurred). Inflammatory reaction then ensues with diffusion of the micro-organisms in the interfascicular lymph-spaces, whence they enter the lymphatic and blood capillaries. A more or less distant point is thus invaded, and then in succession new collections occur, which unite to form diffuse infiltration in a larger or smaller abscess.

[1] It is not due to a "mortification" which "takes place in the vital endowments of the septic organism, whereby it acquires a parasitic habit which enables it to breed in tissues of degraded vitality, or even in the healthy tissues," as stated by Mr. Bellamy, who quotes from Roberts. See Vol. II., p. 30.

[2] Abstract from Gaz. Méd. de Paris, 1884, in Annals of Surgery, vol. i., p. 369.

[3] Duplay et Reclus, tome i., p. 656.

SUPPURATIVE LYMPHANGEITIS.—This occurs in many forms. Toward the termination of a reticular lymphangeitis, little rounded purulent elevations of the epidermis occur, such as form the popularly termed "run-arounds" at the root of a finger-nail. Again, deeper in the derm small purulent collections may form. In ordinary tubular lymphangeitis a series of painful, indurated spots form in the course of the lymph-vessels, which appear successively, do not point as an acute abscess does, but form rounded, fluctuating spots which if opened give vent to a greater quantity of creamy pus than the appearances would indicate. Occasionally the pus resembles more that of a cold abscess, and small sloughs may be detected. Sometimes the number of these purulent collections is great, one case having been reported by Chassaignac with 21; a second, by J. Roux, which required 33 incisions, in a patient on whom two years before, for the same trouble, 22 incisions had been made.[1] Cicatrization usually readily occurs. While often multiple, there may be only one or two abscesses, and they may even, in rare instances, disappear by absorption.[2] Unless followed by a lymph-fistula they usually heal rapidly after evacuation.

In a certain number of cases, much larger circumscribed abscesses may form as the result of a circumscribed perilymphangeitis.

Again the relation between diffuse cellulitis and suppurative lymphangeitis must not be overlooked, for at times, instead of circumscribed collections of pus, this is diffused first along the whole extent of the perilymphatic tissues, whence step by step it infiltrates the cellular tissue until a widespread purulent collection has formed, distending the skin. This, stripped off and deprived of its vascular supply, sloughs; it is a mere step from this to the further involvement of the intermuscular cellular planes, and diffuse cellulitis of the whole limb.

The fistulæ occurring after multiple suppuration along the course of lymphatic trunks, usually open at the position of the lowest abscess. A button of granulations, covered by white or yellowish clots of lymph, usually marks the site. The flow is continuous, drop by drop, but is increased by standing—especially if in the lower extremity—walking, or straining, and may even jet out if pressure be exercised upon the vessel. The amount poured out is said to be less than when the fistula results from damage to a lymph-gland. Fistulæ resulting from suppuration opening into a lymph-trunk usually close in the course of a week or ten days, but they may persist, especially on the penis.

Complications.—Phlebitis, bursitis, and arthritis are far less uncommon than is usually believed, while peritonitis and pleuritis may occur, if the view is correct that lymphangeitis and erysipelas are closely allied if not identical diseases, manifesting their morbid action in somewhat different tissues. Albuminuria is occasionally observed, probably resulting from renal congestion produced by the effort to eliminate microbes or ptomaines. Richet was compelled in one case to cut subcutaneously the contracted lymphatics at the bend of the elbow, as they interfered with its movements.

UTERINE LYMPHANGEITIS.—I cannot agree with Mr. Bellamy that septic uterine lymphangeitis "is invariably fatal," because this disease must result from germs and the ptomaines, toxalbumoses, etc., elabor-

[1] Ibid. [2] Ibid.

ated by them, which can only prove fatal if a vital depravation of the tissues, either primary or secondary, render them efficient; wherefore I believe that a prompt disinfection of the uterine cavity upon the first onset of suspicious symptoms will in some cases reduce the number of germs to a point compatible with successful resistance by tissues, even of lowered vitality.

DEEP LYMPHANGEITIS.—This may follow a similar affection of the superficial trunks.

Symptoms.—When attacking the deep vessels from the start, pain is first felt in the course of the lymphatics, along which a deep knotted induration can be detected, tender on pressure. The glands are swollen, and sometimes there is a little œdema. The skin, at first normal, shows here and there reddened spots overlying the indurated masses. At times the superficial vessels now become involved. Suppuration may either give rise to deep-seated, diffused suppuration, with all its profound septic complications, or may result in deep, circumscribed abscesses, which may even be situated at some distance from the primary inflammatory focus.

Treatment.—Beyond what has been mentioned by Mr. Bellamy, and a caution as to much more rigid asepsis and antisepsis than he has inculcated, I would merely suggest the propriety of the constant application of weak antiseptic lotions, and possibly the adoption of Hueter's advice to inject small quantities of a 2 or 3 per cent. solution of carbolic acid along the course of the affected vessels.[1] The constant application of an ointment of ichthyol, 25 per cent., seemed to me of value in one case.

GANGRENOUS LYMPHANGEITIS.—This chiefly attacks the lower extremities and commences as an ordinary lymphangeitis, but the general condition is from the outset grave, as shown by the occurrence of chills, high temperature, prostration, and early delirium. On the second or third day small bullæ form, which afterward fuse into larger ones, or a large one may exist surrounded by a circle of smaller ones, all filled with fluid, transparent or variously tinged with blood. The early rupture of the vesicles reveals the previously dead derm, pultaceous, whitish or reddish-brown, then greenish or black. The gangrene often extends peripherally, and may destroy considerable skin, the depth of the eschar varying from the superficial layers to the whole thickness of the skin. Oftentimes a diffused phlegmonous inflammation supervenes, frequently terminating fatally. A. M. Jalaguier, who has most carefully studied this disease, distinguishes three forms: (1) A grave form, dangerous from the spreading tendency of the gangrene and from the systemic condition; (2) limited gangrene, but a form where the systemic involvement is most grave; (3) a benign, circumscribed gangrene, with relatively mild constitutional symptoms, where recovery most often ensues.

Treatment.—This must be actively antiseptic, and Jalaguier advises puncturing of sloughs and evacuation of pus, etc., by means of the hot iron rather than the knife, as less likely to lead to renewed infection.

[1] As to the advantages of absorption of antiseptics kept applied to the skin, see Annals of Surgery, vol. iv., p. 429.

TUBERCULAR LYMPHANGEITIS.—That this disease primarily attacks the lymphatics of the limbs has only comparatively recently been demonstrated, it having been confounded with chronic lymphangeitis. In the reported cases, inoculation-tuberculosis of the skin has nearly always given rise to tubercular lymphangeitis. Thus, it has followed a case of anatomical tubercle; a tuberculous verrucous patch on the dorsum of the hand; nodules on the digits, etc.; but occasionally a more deeply seated focus has given rise to it, as in the forearm, from fungous synovitis of the carpal sheaths.

Pathological Anatomy.—Thickened, nodular, of a yellowish-white, the vessels form small knotted cords, the nodules subsequently caseating and forming tubercular abscesses. The walls are at first infiltrated with embryonal cells, and the vessel is surrounded with a wide zone of similar elements; afterward, when the nodules are completely formed, although chiefly due to the perilymphatic exudate, they project into and narrow the lumen, causing stagnation of the lymph which partially coagulates, is yellow, and of a caseous appearance. Microscopically, a caseated centre surrounded by giant-cells and bacilli is always found.[1]

Symptoms.—These are slow and progressive in their development. There may be violaceous red streaks extending in the course of the lymphatics from the original lesion to a varying distance up the limb, but as a rule the skin is not reddened, only an elongated, indurated cord being sensible to the touch, although sometimes also visible to the eye, with nodular masses located at different points. The nodules, at first small, are clearly subcutaneous, rounded, firm and sharply defined, but as they enlarge the skin becomes adherent, they stand out in relief, becoming even as large as an egg or small orange, and soon soften. Connecting these are the hardened, cord-like lymph-vessels which at a later period may present fluctuating points. The knotted cords may extend the whole length of the limb, but often, as in the hand, the disease ceases at the wrist. The glands are attacked, but rarely become much enlarged, nor do they usually soften. The skin over the softened lymphatic nodules thins, finally yielding to give vent to a grumous pus, leaving irregular, crater-like ulcers, with violaceous, thinned, undermined edges. If not cured by treatment, involvement of the glands will follow, and, finally, a generalized tuberculosis.

Diagnosis.—In its typical form this can hardly be confounded with anything but syphilitic gummatous lymphangeitis, but the location and the coexistence of other syphilitic lesions, the more diffused and flattened form of the nodules, and the response to treatment, should resolve all doubt.

Treatment.—Prompt, early, thorough removal, by the knife and cu-

[1] Duplay et Reclus, op. cit., p. 275 et seq. The following may be consulted:—
Lannelongue, Société de Chirurgie, Fév., 1880; Weigert, Die Verbreitung des Tuberkelgiftes nach dem Eintritt in den Organismus, Jahrbuch f. Kinderheilkunde, 1886, Bd. xxi.; Weichselbaum, Wiener medicinische Wochenschrift, 1884, Nos. 12 und 13; Merklen, Société médicale des hôpitaux, 12 juin, 1885, and Annales de Dermatologie, 1888; Martin du Magny, Thèse de doct., Lyon, 1887; Birch-Hirschfeld, Die Geschwülste der Lymphgefässe, Lehrbuch der pathologischen Anatomie, 1887; Hanot, art. Phthisie, Dictionnaire de médecine et de chirurgie pratique; Sanchez, Thèse de doct., Toledo, 1887; Tuffier, Un fait d'inoculation tuberculeuse chez l'homme, Études expérimentales et chirurgicales sur la tuberculose (Verneuil), 1888; Morel-Lavallée, Scrofulo-tuberculose de la peau, Ibid.; Lefèvre, Sur la tuberculose par inoculation cutanée chez l'homme, Thèse de doct., 1888.
I must express my indebtedness to the work of Mm. Duplay et Reclus for all that is given in this section.

rette, of the fistulous openings together with the related glands, is the best practice, although injections with iodoform have proved successful, violaceous cicatrices being left at the site of the nodules; but relapses not uncommonly occur, or new foci develop at other points along the lymph-vessels. Probably the injection of proper doses of Vaughn's "nuclein"[1] and the internal use of iodine would prove useful succedanea.

VENEREAL LYMPHANGEITIS.—This may be *simple* or *specific*.

Simple venereal lymphangeitis may result from any source admitting of infection by pyogenic germs of either a chancre or chancroid, although very rare in the former. There is also apparently a gonorrhœal form, from the gonococcus, although this has not yet been demonstrated by bacteriological examination; but whether caused by the gonococcus or, more probably, by the ordinary pyogenic germs, at times a varicose condition remains, leaving the skin rugous, mammillated and roughened like that of an orange, presenting scattered vesicles. If the lymphatic trunks have been involved they are tortuous and beaded, the enlargements being translucent; lymphatic fistulæ may even result.

Specific venereal lymphangeitis is a very rare complication, and seldom ends in suppuration. It starts ordinarily about the eighth day, showing itself probably by red, ribbon-like streaks upon the dorsum of the penis, with a twisted, knotty, and hard linear median induration; œdema of the prepuce and phimosis follow. Should suppuration occur, several small rounded masses form, which once opened leave fistulous tracks and persistent ulceration, the discharge being inoculable pus identical with that from a chancroid. *Treatment:* This at first is similar to that of the simple variety; afterward that proper for chancroid.

Tertiary Syphilitic Lymphangeitis.—This occurs in two forms, of which the first occurs late, from three to thirty years after infection, and is often located on the genitals near the original seat of the primary lesion; or, again, these cords may connect many gummatous lymph-glands. The cords are hard, rounded, or flattened and slightly irregular, but almost cylindrical. They may sometimes be united into bundles by surrounding induration, rendering their isolation impossible. Interference with the genital function may ensue from their contraction, producing lateral curvature of the penis.

The second variety is a gummatous lymphangeitis of the skin, as in a case of M. Lailler's, presenting a series of projecting, elastic, flattened projections, with their longer diameter corresponding to the long axis of the member and connected together by an indurated cord or band.[2]

The *treatment* resolves itself into that of the tertiary period of syphilis.

TREATMENT OF ADENITIS.—If this affection be the result either of the direct transmission from the infected area of microbes, or theoretically—as in simple contusions—from the absorption of the retrograde products of tissue metamorphosis which so lower the vitality of the gland-tissues that localization of microbes elsewhere gaining access to

[1] The Germicidal Action of Nuclein, by F. C. Vaughn, M.D., F. G. Novy, M.D., and C. T. McClintock, M.D., Medical News, May 20, 1893.

[2] Duplay et Reclus, Traité de Chirurgie, tome i., p. 675.

the blood is effected, the first therapeutic indication is to prevent further absorption of the cause, that is, to treat the infection atrium.[1] The advice given by Mr. Bellamy, in other respects excellent, should be altered to read "aseptic evacuation of pus, followed by rigid antiseptic methods in dressing." Thorough curetting of abscesses resulting from lymphangeitis and, after disinfection, packing with iodoform gauze, will often develop such healthy granulating surfaces that, in a short time after the packing has been removed, fusion of the surfaces will readily occur if they are maintained in contact by compresses.

LYMPHANGEIOMA, ETC.—In many instances these conditions are congenital in origin, possibly the result of mechanical obstruction or blocking of the lymph-current by inflammations arising during intra-uterine life. Those really of post-natal origin are mechanical obstructions due to thrombosis or cicatricial contraction following inflammation, to the pressure of tumors, or to the blocking of lymph-vessels by neoplastic growths (carcinoma, tubercle), or by the filaria sanguinis hominis.

Treatment.—When circumscribed, removal by the knife; when collateral circulation can occur, in the diffused forms, much relief from the œdema may be secured by elevation, by the elastic bandage, and by massage; if stasis cannot be relieved, ligation of the main artery has often enough succeeded to render the operation justifiable, and even the extreme measure of amputation of a member may be warranted.

CHYLE CYSTS.

CHYLE CYST OF THE NECK.—An abstract of the history of the following singular case is worthy of the consideration of surgeons, since it presents points of interest regarding diagnosis and treatment:—

J. S., aged 57, healthy, never having been injured, noticed, one year before presenting himself for examination, a rounded, tense, painless swelling just above the right clavicle, which steadily grew until, when I showed him to my class in Ann Arbor, the whole right inferior carotid triangle was filled by a tense, globular, pulsating mass, extending from the clavicle upward to a level with the angle of the jaw, from the middle of the sternal notch outward to the margin of the trapezius, being bounded on its median aspect by the trachea below, and above by the anterior edge of the sterno-cleido-mastoid muscle, which passed over the swelling; the tumor projected far beyond the level of the clavicle. Neither the skin nor the superficial veins presented anything abnormal, and the only complaint made was of uneasiness from pressure upon the trachea.

Suspecting a so-called hydrocele of the neck, a puncture was made with an exploring needle, which gave vent to such a peculiar fluid that I proceeded to aspirate before incising and draining. A chyle-like fluid to the amount of eighteen ounces was withdrawn, and, during all stages of the evacuation, presented a uniform, very slightly rosy tint, which was more marked upon the surface; the tint apparently deepened upon exposure to the air, while a relatively large clot promptly formed. No trace of thickening remained after emptying this unilocular cyst. The cavity rapidly refilled despite pressure, and twelve days later

[1] The admirable results effected by attention to this advice upon both lymphangeitis and adenitis is well illustrated by the abstract of the history of two cases where corrosive sublimate dressings were substituted for less efficient methods in septic wounds, followed by lymphangeitis and adenitis. See Annals of Surgery, vol. iv., p. 429, from Le Progrès Méd., Août, 1886.

eight ounces of the same fluid were removed. The patient declining radical treatment, a third aspiration was attempted, but only two ounces could be withdrawn owing to the canula becoming blocked.

From the microscopic examination made by Prof. Heneage Gibbes, there can be no doubt that the fluid was chyle. For the anatomical reasons which render such a condition possible upon the right side of the neck, I must refer the reader to Quain's Anatomy, 9th edition, p. 529, and to my original paper.[1]

Treatment.—This can only be palliative, by tapping, unless the surgeon and patient are willing to run the risk of a lymph-fistula if the opening into the duct cannot be occluded. If a radical operation were to be attempted, antiseptic packing should be tried, because dissecting out the sac with ligation of the supplying lymph-vessels would probably be a physical impossibility, owing to the tenuity of the walls and the anatomical relations of the parts. Iodine injections would be hazardous, owing to the necessarily free communication with the large lymph-trunk which empties in this region so promptly into the large veins.

CHYLOUS CYST OF THE MESENTERY.—An instance of this condition, mistaken for an ovarian or parovarian cyst, reported by Dr. A. Rasch, presents certain points of interest:—

A Jewess, aged 21, had a rounded elastic tumor occupying mainly the left side of the abdomen, its upper limit reaching two inches above the umbilicus. When the abdomen was opened the tumor was found of a pale pink color, and "very glossy," unlike any ordinary abdominal cyst. "A perfectly milk-like fluid squirted out with great force" when the cyst was tapped,[2] the walls being seen upon further examination to be merely the two layers of the mesentery separated from one another by the collection of fluid. The small intestine was normally related to the mesentery, which in turn originated from the usual point. The interior of the cyst was intensely congested, of a dark-red color, and oozed freely. The edges of the incised mesentery (cyst) were stitched to the skin wound, and recovery ensued.[3]

Treatment.—This is well illustrated by the case quoted; no attempt should ever be made to dissect out the cyst itself.

ELEPHANTIASIS ARABUM.

The common cause of this disease, chyluria and chylocele, or chylous hydrocele, with numerous other lymphatic affections, is so clear,

[1] Transactions of Am. Surg. Association, vol. x., p. 201.

[2] F. Bramann reports from von Bergmann's clinic an interesting case where no discharge of chyle occurred after evacuation of the cyst. He thinks that stenosis of the thoracic duct is present in most cases, although this sometimes produces only dilatation of the lymph-trunks; but here Bramann thinks that the thoracic duct was double, or pursued an anomalous course. No evidence existed at the time of operation of any pressure on the main duct, since the lymphatics of the intestines were not dilated. The absence of epithelial or endothelial lining excludes a secretion from the cyst-wall itself, and Grawitz's theory as to small peritoneal cysts will not avail. Rokitansky's view as to the genesis from a lymph-gland is untenable. Bramann concludes that the cyst may have originated from a dilatation of the receptaculum chyli, or from a subperitoneal cavernous lymphoma or angeioma, such as has been described by Virchow (Annals of Surgery, vol. vii., p. 395, from Arch. f. klin. Chir., Bd. xxxv., Hft. 1).

[3] Transactions Obst. Society, London, vol. xxxi., p. 311; J. Bland Sutton, Surgical Diseases of the Ovaries and Fallopian Tubes, etc., 1891, p. 195. According to Sutton, cysts similar to the above have been reported by Bergmann, Arch. f. klin. Chir. (Langenbeck), 1887, S. 201; Mendes de Leon, Am. Journ. of Obstet., vol. xxiv., p. 168; and Fetherston, Australian Med. Journal, 1890, p. 475.

that an account of the principal facts pertaining to the discovery, life history, and pathological effects of the filaria sanguinis hominis and its parent the filaria Bancrofti, will be subjoined. Otto Wucherer, of Bahia,[1] first described in 1866 embryonic filariæ detected in chylous urine, but Klencke in 1843 possibly discovered similar organisms in the blood, though his descriptions are too vague to decide this question. T. R. Lewis,[2] of Calcutta, in 1872 detected filariæ in the blood of a native, and afterward in that of several individuals who were or had been chyluric. Bancroft, of Brisbane,[3] on December 21, 1876, obtained a dead female filaria from a lymphatic abscess of the arm, possibly having been slightly antedated in this discovery by Carter, of Bombay.[4] Carter next reported the withdrawal of four living female filariæ from a hydrocele of the spermatic cord, while Lewis secured both the male and female worm alive from the scrotal tissues in a case of nævoid elephantiasis of the scrotum.[5] Manson[6] reported in 1880 the finding of a living worm in a dilated lymphatic of the scrotum, thus determining the habitat of the filaria Bancrofti (the adult organism), in a patient who had had craw-craw and chyluria. He contends that the female, occupying a lymph duct, emits the embryos, which are small enough to pass through the lymph glands and thence reach the blood. Both Manson and Lewis have found the embryo entozoons in the stomach of the culex mosquito, this insect having abstracted them with the blood from an infected human being; many are digested, some are cast off, others bore through the stomach and undergo developmental changes in the thoracic and abdominal tissues. After escape from the living or dead insect they probably, as free nematodes, contaminate potable water, by means of which vehicle they reach the human organism. "Filarial periodicity" must not be overlooked when searching for these hæmatozoa in any suspected case, since they only begin to appear at sunset, increase in numbers until midnight, then diminish until about 10 o'clock in the forenoon, after which it is rarely possible to detect them. By changing the habits of eating and sleeping, it has been alleged that an "inversion" of this process can be effected. Manson's theory of elephantoid diseases seems to give the best explanation, and is as follows: "1st, parent filaria in a distal lymphatic; 2d, premature expulsion of ova; 3d, embolism of lymphatic glands by ova;[7] 4th, stasis of lymph; 5th, regurgitation of lymph and partial compensation by anastomoses; 6th, renewed or continued expulsion of ova; 7th, further embolism of glands."[8]

[1] Gazeta Medica da Bahia, Dec., 1868, p. 99.

[2] On a Hæmatozoon Inhabiting Human Blood, its Relations to Chyluria and other Diseases: by T. R. Lewis, Eighth Ann. Report Sanitary Com. with Government of India, 1871, Appendix E, Calcutta, 1872; See also Quain's Med. Dict., art. Chyluria. I would here express my indebtedness to W. M. Mastin's article on Filaria Sanguinis Hominis in the Annals of Surgery, vol. viii., p. 321, for the information contained in this abstract.

[3] Cobbold, Parasites, A Treatise on the Entozoa of Man and Animals, including Some Account of Ectozoa, p. 186. London, 1879.

[4] Sir J. Fayrer, On the Relation of Filaria Sanguinis Hominis to the Endemic Diseases of India. Lancet, Feb. 8, 1879, p. 188.

[5] Indian Medical Gazette, Sept. 1, 1877.

[6] Chinese Imperial Customs Med. Reports, No. XIV., 1878.

[7] The semi-spherical ovum when coiled up in its sheath cannot pass through the glands, while the outstretched embryos, having a diameter about that of a lymph-cell, can readily pass and do not block the lymph current.

[8] This may be complete, preventing any filariæ from reaching the blood, explaining their absence in that fluid in certain cases where they abound in the lymphatics.

I shall briefly enumerate the following surgical affections which have been found to be commonly of filarial origin: Chylocele; varicocele;[1] helminthiasis elastica (varicose or cavernous lymphangeioma) of the groin and axilla; lymph-vesicles on the abdomen and scrotum; craw-craw; acute orchitis; abscess of the scrotum and cervical lymphatic glands; abscess of the lymphatics of the arm and thigh; intrapelvic abscess; peculiar steatoma of the face; venous varix; and of course all the varieties of undoubted elephantiasis Arabum.

Since the worm is a native of such widely separated countries as are contained in the subjoined list, it behooves all to remember the possible presence of this hæmatozoon, or lymphazoon, when investigating any case of the diseases above mentioned. It has been found and is believed to be a native of Brazil, India, Australia, Egypt, the East and South African coasts, China, the West Indies, and the Southern part of the United States of America, viz., Charleston, S. C., and Mobile, Ala.

CRAW-CRAW.—This disease, proved to result from the presence of filariæ, attacks the negroes of the South African coast. According to O'Neill it closely resembles scabies in all its stages, appearing in the clefts between the fingers, on the front of the wrist, the back of the elbows, but seldom on the face. It is contagious, with an incubation period of about three days. Craw-craw is popularly believed to become latent upon removal to a cooler climate, as that of the Cape, only to burst out with all its old violence upon return to a tropical region.

Symptoms.—Small, firm papules develop on the parts mentioned, which slowly increase to the size of pin heads. They are usually discrete, but sometimes accidentally assume a crescentic or annular form. In about two days vesicles replace the papules, and in forty-eight hours more are converted into pustules; these latter rapidly increase in size, oftentimes merging with other contiguous pustules. As intense itching attends all stages of the affection, from scratching pus is effused, and, drying, forms large, irregular, unsightly scabs.[2]

Treatment.—This seems unsettled, as sulphur is of doubtful value, while O'Neill says that the natives seem to know of nothing which exerts any influence on the disease, and suggests no remedies himself. As change to a colder climate is alleged to render the disease latent, this should be tried, with sedative remedies; possibly some anthelmintic remedy locally employed might be useful.

CHYLOCELE OF THE TUNICA VAGINALIS TESTIS.—While this may be due to any obstructive adenitis of one or more of the glands through which the lymph is returned from the testicle, causing dilatation followed by rupture of a lymphatic trunk into the tunica vaginalis testis, yet in most cases it is of filarial origin.

Symptoms.—I need spend but little time on these, as they are identical with those of ordinary hydrocele, with perhaps in addition some enlargement of the lymphatic glands in the groin. Tapping first reveals the condition by giving vent to a milk-like or chylo-serous, coagulable fluid; in rare instances the fluid may not be even opalescent, but may appear identical with ordinary hydrocele fluid, yet on a closer ex-

[1] Fayrer, Lancet, Feb. 15, 1879, p. 222.
[2] O'Neill, Lancet, Feb., 1875.

amination it will be found to be lymphoid, and to be produced by and to contain the filaria.

Treatment.—While iodine injections may in rare instances cure, experience has shown that the better procedure is incision of the tunica vaginalis, and the application of a ligature to the leaking lymph-vessel.

INJURIES AND DISEASES OF NERVES.

BY

JOHN B. DEAVER, M.D.,

ASSISTANT PROFESSOR OF APPLIED ANATOMY IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PHILADELPHIA HOSPITAL, TO THE GERMAN HOSPITAL, TO ST. AGNES'S HOSPITAL, ETC., PHILADELPHIA.

TRAUMATIC LESIONS OF NERVES.

DISLOCATION OF NERVES.—This is a form of injury that is occasionally encountered. The ulnar nerve has been found displaced from its normal position at the elbow after certain violent movements, as in fencing; loose connections of the nerve, small size of the internal condyle of the humerus, and marked prominence of the internal lateral ligament predispose to the occurrence of this accident, according to Zuckerkandl. It may also follow fractures of the internal condyle. Dislocation of the peroneal nerve in fractures of the head of the fibula has been seen. The subjective symptoms consist in pain, and motor and sensory disturbances. The treatment would be to replace the nerve, place the limb at rest in the proper position, and, if need be, apply anodynes. For habitual luxation of the ulnar nerve, Kölliker advises deepening of the groove wherein it lies, and suturing the parts; cicatricial contraction would tend to retain the nerve in its place.

PHENOMENA CONSECUTIVE TO INJURIES OF NERVES.

REGENERATION OF NERVES.—Benecke, Gluck, Backowetzki, and others believe that the nuclei of the primitive sheath of the nerve forms the new axis cylinder, basing their views upon experiments on lower animals. Bowlby[1] coincides with this view, and has observed this mode of reproduction of the axis-cylinders in pieces taken from the peripheral portions of divided human nerves; he also says that "the peripheral end may become regenerated without forming any union with the proximal extremity, but that it again tends to degenerate if union fails." Th. Kölliker[2] absolutely denies that any other elements besides the axis-cylinder itself (that is, its proximal portion) have anything to do with the regeneration of this tissue, which is an outgrowth from the epiblastic ganglion cells.

[1] Injuries and Diseases of Nerves.
[2] Die Verletzungen u. Erkrank. der periph. Nerven.

Inflammatory Lesions of Nerves.

Neuritis.—Occasionally there are observed thickenings of peripheral nerves of the paralyzed side in cases of cerebral hemorrhage; this condition has been called "neuritis hypertrophica," and Charcot believes it to be due to trophic influences. In the neuritis of anæsthetic leprosy, the bacillus lepræ has been found in the connective tissue of the nerves. Möbius has described a form of neuritis occurring in the puerperal state, to which he has applied the name of "neuritis puerperalis;" the disease affects particularly the nerves of the upper extremity. The cause is not known. Tubercular and syphilitic inflammation are, according to Ziegler, most often seen in the cranial portions of the cranial nerves and in the roots of the spinal nerves.

Multiple Neuritis.—It has been suggested that this disease, in which there is a parenchymatous inflammation of many of the peripheral nerves, is of an infectious nature. It has been quite frequently seen in connection with pulmonary phthisis (Strümpell), and has been observed after influenza.

The peculiar affection known as "beri-beri," or "kak-ke," which is met with in the East Indies, Islands of the South Pacific, etc., has been shown by Balz, Scheube, and others to be a form of multiple neuritis; it seems to be due to micro-organisms which exist as rods and as cocci, and are found in the air and soil, and in the blood of persons affected. The symptoms of beri-beri are those of neuritis, affecting particularly the nerves of the lower extremities, and the branches of the pneumogastric which are distributed to the heart. Disturbances of sensation and motion, paralysis and wasting of muscles, œdema, and cardiac murmurs are developed. The disease is usually chronic, and death, when it occurs, is most often due to cardiac failure.

Treatment: Removal from the infected locality is, of course, the first requisite; an attempt at disinfecting the surroundings should be made; rest is very important, especially as the heart is affected; strychnine, quinine, and digitalis are appropriate remedies.

Neuralgia in General.

Neuralgia.—Dana[1] and Putnam[2] state that in many cases of trifacial neuralgia, obliterating endarteritis of the vessels supplying the affected nerve may be found. Putnam, Horsley, Rose, and others have described sclerotic changes in the nerve fibres and in the Gasserian ganglion. Putnam also lays stress on the fact that the trifacial nerve has a very extensive, deep origin, and many connections with other nerves which render it particularly liable to disturbing influences; it has also been asserted that a neuritis may be caused by repeated and severe "nerve storms" traversing the nerve track. The size of the foramen ovale has been investigated by Carless, who finds considerable variations in its diameter, and this may possibly be a causative factor

[1] Journ. of Nerv. and Ment. Dis., No. 1, 1891.
[2] Bost. Med. and Surg. Journ., Aug. 20, 1891.

in the production of neuralgia. Gussenbauer has reported cases of reflex neuralgia due to constipation.

METATARSALGIA.—Morton's "painful affection of the foot," or metatarsalgia, was first described by Dr. T. G. Morton, of Philadelphia, in 1876.[1] It consists of severe neuralgic pain radiating from the head of the fourth metatarsal bone. There are no marked signs of inflammation, but there is tenderness on pressure over the articulation. Morton believes it to be due to pressure upon the plantar digital nerves, particularly the fourth, for on account of the anatomical conformation of the parts, the head of the fifth metatarsal is so placed that when lateral pressure is applied it will impinge upon the head and neck of the fourth metatarsal, and nerve filaments may thus be pinched or squeezed. The disease may be caused by some traumatism, as a twist of the foot, or some unusual exertion may precipitate an attack, especially if ill-fitting shoes are worn. Sometimes no cause is apparent. Women are oftener affected than men. From frequent repetitions of the pain, or perhaps from an ascending neuritis, various neurotic disturbances may arise. In the acute form of the affection the pain may be almost intolerable, and patients are unable to bear the loosest shoe.

The *treatment* advised by Morton in mild cases consists in rest, the application of a flannel roller over the ball of the foot, and the subsequent wearing of broad, properly fitting shoes so as to avoid all pressure. Others have secured relief by alternate hot and cold douches and local anodynes, together with rest. In severe cases, Morton excises the metatarso-phalangeal articulation of the fourth toe, or sometimes amputates this toe with the head of the fourth metatarsal, securing in this way a complete cure.

TUMORS OF NERVES.

NEUROMA.—Bruns[2] regards the plexiform neuroma as a form of congenital elephantiasis.

TETANUS.

TRAUMATIC TETANUS.—Of late the microbic origin of this disease has become firmly established. Carle and Rattone, in 1884, first showed it to be an infectious disease by inoculating rabbits with the pus derived from the wound of a patient suffering with tetanus, and producing thereby fatal tetanic convulsions. Nicolaier showed that a specific form of bacillus was present in various kinds of soil, which was capable of producing tetanus in the lower animals when inoculated. Subsequently, Rosenbach demonstrated that the bacillus found by Nicolaier could also be found in the wound secretions, and in the neighborhood of the point of entrance in the human being; and many other investigators have confirmed these statements.

In inoculation experiments it was found that bacilli existed only in the immediate vicinity of the wound and in its secretions, but not in

[1] Amer. Journ. Med. Sciences, Jan., 1876.
[2] Beit. zur klin. Chir., Bd. viii., Heft 1.

the blood or internal organs, or, at least, only to a very slight extent. It, therefore, seemed plausible that the symptoms of the disease were caused by chemical poisons generated by the vital activity of these micro-organisms. Brieger has isolated four of these toxines from cultures of the bacilli, and has applied to them the names: tetanine, tetanotoxine, spasmotoxine, and muriate of toxine. Brieger has also found tetanine in the recently amputated arm of a patient affected with tetanus. Wely and Kitasato have isolated from pure cultures a very poisonous substance, allied to the albuminoids, by the inoculation of which typical tetanus can be produced. Brieger and Fränkel have also isolated this substance, and it is probably to be regarded as the true tetanus poison.

The bacillus tetani is an "obligatory anaërobic" existing in the shape of a delicate rod, and, as usually seen, having the appearance of a drumstick, owing to the presence of a spore at one extremity; its mobility is slight. The bacilli can be readily stained with an alkaline alcoholic solution of methyl-blue; also with fuchsin, and by Gram's method. They grow slowly, best in an atmosphere of pure hydrogen at a temperature of 98.6° F. When stab cultures are made in gelatin, containing 2 per cent. of grape-sugar, there develops in the deeper part, at a distance from the atmosphere, a rod-like growth from the sides of which pass out streaks into the surrounding medium; at a later stage, the gelatin becomes cloudy, liquefies, and a gas of peculiar odor is set free. Pure cultures are found very difficult to obtain, but Kitasato and others have succeeded in securing them. The spores are very resistant to heat and to the ordinary antiseptics. Rosenbach found that it required fifteen hours' exposure to a 5-per-cent. carbolic acid solution to render them innocuous. Kitasato found that moist heat of 212° F. destroyed the spores, as did also exposure for thirty minutes to 1–1000 bichloride of mercury solution. The bacilli are found in street dust and dirt, manure, and in various soils, particularly in hot countries, for which reason, probably, the disease is more common in those regions. In patients affected with the disease, the micro-organisms are found in the vicinity of the wound and in its secretions, but only in very small numbers, and often not at all in the blood and central nervous system, owing to the fact that the oxygen carried by the red corpuscles is inimical to their development, while the wound secretions prevent access of oxygen to the site of infection (Woodhead). The bacillus tetani is non-pyogenic, hence infection may occur without the presence of pus. It effects an entrance into the body through some lesion of continuity, not being able to pass through sound mucous membrane or skin. It has been suggested that the cases of so-called idiopathic tetanus, in which there is no apparent place of ingress of bacilli, can be explained by supposing that they had entered through some former lesion of continuity and had become encapsulated; that then, through failure in health or some traumatism, they have been liberated, and that, thereupon, the symptoms of tetanus have arisen; or the original wound may have been so insignificant as not to attract attention. In infants, trismus nascentium is caused by the bacillus entering at the site of the umbilicus.

The period of incubation varies greatly in length, sometimes being only twenty-four hours or less, at other times weeks, depending upon

the number of bacilli which have entered, the location of the point of infection, the histological characteristics of the surrounding tissues, the degree of virulence of the micro-organisms, and the susceptibility of the tissues to the action of the ptomaines (Senn).

According to Kitasato, to whom we owe so much of our knowledge of this bacillus, infection in man usually occurs by spores which are introduced on some foreign body. The reason that wounds of the extremities are comparatively often followed by tetanus, is to be sought in the fact that the agents producing these injuries have upon them the spores from contact with the soil, and that the parts themselves are often begrimed with dirt. Wounds of considerable extent are not so often followed by the disease, because, as has been suggested, they are more apt to be efficiently cleansed and dressed than are small wounds. In punctured wounds, the conditions for the growth of the bacilli are more favorable owing to the exclusion of air and light.

There has not been found much to add to the result of former investigations as to the morbid anatomy of tetanus. Obliteration of the central canal of the spinal cord, and disintegrative changes in the posterior horns, have been found by Tyson. Monastyrski has found semilunar extravasations of blood in the interstitial connective tissue of the cord and peripheral nerves, and granular infiltration of the nerve cells. The bacilli, or rather their poisonous products, probably produce changes in the nervous matters, the exact nature of which future investigations must determine. Recently, tetanus-toxine has been found in the kidneys and urine of human beings and of animals suffering from tetanus, showing that nature makes an effort to eliminate the poison by the kidneys.

Prophylaxis and Treatment.—Of course strict antiseptic and aseptic procedures are necessary for the prevention and cure of tetanus. All wounds, even the most insignificant, are to be thoroughly disinfected and kept so, especially if, from the nature of the injury and circumstances surrounding it, infection with the germ seems probable. Tizzoni and Cattani, basing their advice upon experiments on lower animals, advise the disinfection of a suspicious wound with a $\frac{1}{10}$ to 1 per cent. solution of nitrate of silver, and for the further treatment of the case, if tetanus develop, a mixture of 1–1000 solution of bichloride of mercury, 5-per-cent. solution of carbolic acid and $\frac{5}{10}$-per-cent. solution of hydrochloric acid. Punctured wounds are to be enlarged so that the germicides may be brought into contact with the deeper tissues. Packing the wound with iodoform has been advised by Sormanni. The usual antispasmodics, etc., are to be given to lessen the intensity of the convulsions, and a supporting treatment is to be adopted. Amputation for already existing tetanus is to be regarded as an irrational procedure. Baccelli and others have reported cures by the injection of solutions of carbolic acid. Baccelli used 0.01 gramme every hour. De Renzi has cured three out of four cases by absolute rest; the patient is placed in a dark, quiet room, cotton is put into the external auditory meatus, liquid food is poured directly into the mouth of the patient, and ergot and belladonna are administered.

By the injection of small amounts of blood serum derived from animals affected with tetanus, Behring and Kitasato have produced immunity to the disease in animals; they have also cured animals by the

injection of blood serum from other animals affected with tetanus. Tizzoni and Cattani, moreover, have prepared from the blood serum of animals thus rendered immune, a substance called tetanus anti-toxine. This substance, injected hypodermically, is said to have cured a number of cases of tetanus in human beings. Schwarz, Taruffi, Casali, Moritz, and others have reported such cases.

TETANUS HYDROPHOBICUS.—According to Rose and others, there occurs a peculiar form of tetanus after certain injuries to the regions supplied by the cranial nerves. In this form of the disease, which is sometimes known as cephalic tetanus, there occur trismus, paralysis of the facial nerve, and spasms of the pharyngeal muscles; from the last-named symptoms, owing to their resemblance to hydrophobia, the disease has been called tetanus hydrophobicus. Klemm recognizes two forms of tetanus following injuries in the regions supplied by the cranial nerves: in the first, the muscles in the neighborhood of the injury first become affected, and the process spreads thence; in the second, there is paralysis of the facial nerve as well as tetanic contractions of the muscles of the face. There are an acute and a chronic form of tetanus hydrophobicus, the former being far more fatal. Brunner has produced the disease in animals by inoculations of pure cultures of tetanus bacilli; he denies that there is palsy of the facial nerve, and says that the contractions of the muscles produce an asymmetry of the face which makes it appear as though there was paralysis, and that the facial paralysis is an error of observation. It may be considered settled, however, that there is a form of tetanus in which facial paralysis exists, usually upon the injured side, as numerous careful observers have noted it. Ptosis also has been noted in several cases.

The cause of the paralysis is not definitely known. Rose attributes it to swelling and inflammation of the nerve in the Fallopian canal, but autopsies fail to confirm this view. Gowers says that it is reflex. Nearly all the autopsies have given negative results; in one case there were found vacuoles in the cells at the origin of the facial and trifacial nerves.

In America this form of the disease seems to be less common than in Europe: during the Civil War there were 21 cases of tetanus following head injuries, yet paralysis of the facial nerve was not observed.

TETANY.—This disease is usually regarded as a neurosis, which manifests itself by tonic spasms, more especially of the muscles of the limbs, accompanied by increased excitability of the peripheral nerves, and, in many cases, by pain, elevation of temperature, various paræsthesiæ, and vasomotor disturbances. Of peculiar interest to the surgeon is the fact that it very often follows complete removal of the thyroid gland, as was first shown by N. Weiss and as has since been confirmed by numerous investigators. Of this so-called "post-operative tetany," von Eiselsberg reports 12 cases, all in females, occurring in 53 cases of complete removal of the thyroid gland by Billroth; of these 12, 8 ended in death, 2 became chronic, and but 2 terminated in recovery. In 109 partial extirpations of the thyroid gland, tetany did not occur. Von Eiselsberg also made experiments upon more than 100 cats, and draws the conclusion that total removal of the thyroid gland gives rise to

tetany, whereas partial removal does not. In certain other animals, as sheep and rabbits, these results do not occur. Why complete thyroidectomy should cause tetany, and also myxœdema and cachexia strumipriva, which frequently accompany the former affection, is not known; nor will it be until the, at present, mysterious function of the thyroid gland becomes known.

Symptoms.—General malaise and painful sensations coming on soon after the operation, or after an interval of several days, generally precede the muscular spasms, though not always. The spasms nearly always begin in the muscles of the forearm, and then attack the lower extremities. Sometimes the facial muscles are first attacked. Both sides of the body are as a rule affected, and the flexor muscles are chiefly involved, leading to contractures. "Trousseau's phenomenon," which is highly characteristic of this disease, consists of spasms of the limb muscles brought on by pressure upon the main arterial and nerve trunks of the extremity. "Chvostek's sign" consists of contractures of the facial muscles, caused by pressing or tapping upon the seventh cranial nerve at its point of emergence from the parotid gland. This symptom is regarded by von Jaksch as even more characteristic of tetany than "Trousseau's phenomenon." The duration of the individual spasms is from a few seconds to several minutes; of the entire disease from two or three days to several weeks; some cases may become chronic. Consciousness is preserved. Dyspnœa often exists owing to spasmodic contraction of the diaphragm and thoracic muscles. In the intervals between the attacks the electrical and mechanical excitability of the nerves is exaggerated. The bodily temperature is often elevated, and the frequency of the pulse is moderately increased. Pain, tremors, œdematous swelling, and excessive secretion of sweat have been met with.

Another form of the disease is the epidemic tetany, occurring most often in the spring; then there is a variety of the disease due to lowering of the general standard of health from long-continued diarrhœa, over-lactation (*contracture des nourrices*, Trousseau), rickets, certain fevers, etc. There is also a form which is met with in some cases of gastrectasis, as first mentioned by Gerhardt. The symptoms of these varieties of tetany are in general the same as those detailed above for the post-operative form. Von Jaksch, who has studied a large number of cases of epidemic tetany, noted 36 males and 5 females. The affection was most common among the followers of certain trades, notably among shoemakers. It was met with most often at about the age of 17 or 18. No hereditary taint could be traced in his cases. Post-mortem examinations have, thus far, given no definite results.

Diagnosis.—The diagnosis from tetanus is to be made by considering the etiology of the disease, by the fact that in tetanus the spasms begin in the masticatory muscles and are more general, and that there are no periods of relaxation. Trousseau's and Chvostek's signs will also be of avail in differentiating tetany from tetanus. The carpo-pedal spasms, which are often seen in rickety children, along with laryngismus stridulus, are not to be mistaken for true tetany. The *prognosis* is favorable, except in cases of post-operative tetany, and in that form which is associated with gastrectasis.

Treatment.—The general hygienic management is, of course, to be

attended to. Of drugs, chloral, morphia, and the bromides may be given. Berger has seen good results follow the use of curare administered subcutaneously. Electricity is often of use. An ice-bag may be applied to the spine, and tepid baths may be made use of.

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Operations which are Practised upon Nerves.

Nerve Stretching.—Bowlby has collected thirteen cases in which death occurred after nerve stretching, from injury to the spinal cord.

Nerve Extraction (Thiersch, Witzel).—This operation consists in exposure of the affected nerve, seizing it with an appropriate pair of forceps, and twisting and tearing it away along with many of its peripheral branches. Thiersch has reported twenty-four cases where the operation was done on branches of the trigeminus, with good and permanent results in all but two. He states that there is not much danger of atrophy following the operation. *Division of the posterior roots* of the spinal nerves has been performed by Abbe, W. H. Bennett, and others in cases of severe neuralgia and of spasms accompanied by pain. The operation is done by removing the laminæ of one or more vertebræ and dividing the posterior roots as they lie in the spinal canal. The value of this procedure has not yet been determined.

Nerve Suture.—When the ends of a divided nerve are sutured immediately after the injury, the procedure is known as "primary suture;" when it is done later, as "secondary suture." Bowlby advises that the ends be sutured under all circumstances, whether they come into apposition without it or not. He advises also to pass the thread through the entire nerve; but Kölliker[1] says that it is preferable to employ the paraneurotic suture unless there is great tension, or when the ends cannot readily be brought together, as the sutures offer more or less of a hindrance to union. Bowlby, Gluck, and others believe primary union to be possible, and numerous cases are reported where this is said to have occurred. Even after secondary suture apparent primary union has been obtained, in cases reported by Nicaise, Langenbeck, and others. Howell and Huber, Cahn and others, however, draw the conclusion from experimental investigation that primary union does not occur.

Eighty-one cases of primary nerve suture have been collected by Bowlby; of these 32 were completely successful, 22 were partial successes, in 12 the result was doubtful, 14 were failures, and in one the

[1] Die Verletzungen u. chir. Erkrank. der periph. Nerven, Deutsche Chirurgie, Lief. 24, b.

result was not known. Of secondary suture he has collected 73 cases, with 32 successes, 26 partial successes, and 15 failures.

NERVE GRAFTING.—Successful results have been obtained by Robson, Landerer, and others. Assaky has suggested the use of loops of catgut between the divided nerve ends to aid in the healing process; it is not possible at the present time to state definitely the value of this procedure. It has also been suggested to introduce a decalcified bone tube between the ends of the nerve, on the supposition that nerve tissue would be prolonged into the calibre of the tube.

OPERATIONS FOR TRIFACIAL NEURALGIA.—*First Division.*—The *supra-orbital nerve* may be readily exposed by making an incision along the upper margin of the orbit, parallel with the fibres of the orbicularis palpebrarum, the centre of the incision corresponding to the supra-orbital notch or foramen. After division of the orbicularis and the fibrous membrane of the lids, the nerve may be seized and a portion excised. The *supra-trochlear nerve*, the other terminal branch of the frontal, which makes its exit from the orbit between the supra-orbital foramen and the pulley for the superior oblique, may also be reached by an incision along the upper margin of the orbit, nearer the internal canthus.

Second Division.—Subcutaneous division of the *infra-orbital nerve* at its foramen of exit was formerly practised, but at the present time is not considered desirable. To resect a portion of this nerve it is simply necessary to make a semilunar incision over the infra-orbital margin, parallel with the fibres of the orbicularis palpebrarum; the nerve makes its exit under the levator palpebræ superioris; upon finding it here, a portion is excised, or the method of Thiersch may be followed: this consists in seizing the nerve with a pair of forceps and, by rotating the instrument, coiling up the nerve on the forceps and finally tearing it away; thus not only the proximal but also the distal portion is torn away, and in this manner quite a long piece may be removed. Wagner, after exposing the nerve, raised the orbital contents from the floor of the orbit, separated the artery from the nerve, chiselled open the canal, and then severed the nerve behind the posterior dental branches. Fowler compared this method with the removal of Meckel's ganglion, and found that the latter method gave slightly better results. Horsley has described a similar operation: in this, the lids are first sutured together, the orbital periosteum is raised up, the canal opened with a pair of forceps, and the nerve traced to the foramen rotundum, where it is divided.

In Carnochan's method, which was suggested and carried out for the first time in 1858, Meckel's ganglion is removed along with the nerve. A "V" or "T" shaped incision is made upon the cheek, and the infra-orbital foramen exposed; the anterior wall of the antrum of Highmore is trephined, and then the posterior, using a smaller trephine for the posterior wall; the floor of the infra-orbital canal is broken through, and the nerve is traced back to the foramen rotundum, where it is divided with a long curved pair of scissors and removed along with Meckel's ganglion. Bleeding from branches of the internal maxillary artery will be rather profuse, and electric light or a reflecting mirror will be found very useful.

The second division of the trifacial nerve has also been attacked through the *pterygo-maxillary* region. In the method of Professors Braun and Lossen, an incision is made from a point 1 cm. above the outer canthus and 2 or 3 mm. from the outer margin of the orbit, downward and forward, to the lower border of the zygoma; another incision is made from the upper end of this, along the upper border of the zygomatic arch, to about the position of the tragus; the skin and subcutaneous tissue are then turned down, the temporal fascia is divided, and the zygoma is severed at both ends so that it, with the masseter muscle arising from it, can also be reflected downward; then the anterior border of the tendon of the temporal muscle, the fat and the internal maxillary artery, and a venous plexus, are drawn backward; the nerve is sought for as it passes through the spheno-maxillary fissure, drawn outward with a strabismus hook, and divided at the foramen rotundum. If it is desired, an incision may then be made over the infra-orbital foramen, and the nerve excised. The zygoma is then replaced and fastened by periosteal sutures or by wiring. Tillmans, in five cases operated upon by this method, secured firm bony union, and no deformity remained.

Third Division.—The inferior dental nerve may be divided or resected at the mental foramen, either by incising the mucous membrane of the lower lip or by making the incision through the integument. Neither of these procedures, however, gives satisfactory results.

Exposure in the Inferior Dental Canal.—The *inferior dental nerve*, the largest of the three sensory branches of the third division of the fifth cranial nerve, may be exposed by turning up a flap from the inferior maxilla, and then trephining the bone; when the disc, consisting of the external layer of the maxilla, is removed, the nerve will be seen lying with its accompanying artery in the inferior dental canal, and a portion of the nerve is then resected. If the anterior wall of the canal is chiselled away for some distance, a much longer portion of the nerve can be removed, thus tending to prevent reunion of the ends.

The nerve may also be reached before its entrance into the inferior dental canal, by attacking it from within, that is, through the mucous membrane of the mouth; secondly, behind the ramus of the jaw (Lücke, Sonnenburg), and thirdly, through the ramus of the maxilla.

The *intra-buccal method* consists in making an incision through the mucous membrane and periosteum, one inch in length, along the inner aspect of the anterior border of the ramus of the inferior maxilla, the mouth being held open with a gag and the tongue drawn to the opposite side; the internal pterygoid is raised from the bone and the internal lateral ligament divided, the point where it is inserted, viz., the spine of Spix, or the lingula, having been previously recognized. The nerve is then freed from its accompanying vessels and a portion of it excised. To this operation various objections may be urged: there is but little room for the manipulations, only a small portion of the nerve can be removed, and hemorrhage from the inferior dental artery is difficult to check, even requiring in some cases ligation of the external carotid.

The *lingual branch of the fifth nerve* may also be resected by the intrabuccal method. An incision is made through the mucous membrane over the course of the nerve, which lies at a point corresponding to the junction of the upper and middle thirds of a line drawn from the angle

of the jaw to the last molar tooth (Rose). Pulling the tongue forcibly to the opposite side will make the nerve tense; it is then picked up with a strabismus hook and a portion excised.

To excise the *inferior maxillary nerve* by the Lücke-Sonnenburg method, the incision begins about one inch above the angle of the jaw, and is carried along the posterior edge of the maxilla to the angle, and along the lower border of the ramus to its middle; the fascia covering the parotid is then incised, the lower part of the gland raised up, and the internal pterygoid muscle raised from the maxilla. After locating the spine, into which is inserted the internal lateral ligament of the lower jaw, the nerve can readily be reached, for it lies below that ligament and the bone. When it is desired to divide the nerve at the foramen ovale, through the ramus of the jaw, various methods may be employed. Pancoast first performed this operation; and various methods have since been proposed by Salzer, Krönlein, Mikulicz and others. The method devised by Horsley, and preferred by Mr. Rose, of London, consists in deepening the sigmoid notch, and is thus described by the latter surgeon:—

Commencing about the middle of the zygoma, the knife is carried backward and downward over the parotid region to the angle of the jaw, and then for a short distance along the horizontal ramus. A semilunar flap, consisting of skin and subcutaneous tissue only, should be raised and turned forward, and for convenience temporarily stitched across the opposite side and carefully protected. This flap must be so dissected as not to injure any of the branches of the facial nerve. By this means are exposed the masseteric fascia, the branches of the facial nerve, Stenson's duct, and a portion of the parotid gland. The deep fascia and masseter muscle are then divided by a transverse incision below and parallel to Stenson's duct, cutting directly down to the bone about a centimetre below the sigmoid notch. Great care must be taken not to wound any of the lobules of the parotid while so doing, for although the main duct may not be divided a salivary fistula may ensue, leading to interference with the healing of the wound. The outer surface of the jaw is next denuded of periosteum by means of raspatories, and the soft parts held aside by suitable retractors to allow of the application of a trephine, the diameter of which should be not less than ¾ inch. It should be so applied as to leave between it and the sigmoid notch a narrow bridge of bone which can be subsequently clipped away by cutting pliers, and a sufficient amount of bone in front and behind to preserve the continuity of the jaw with the articular and coronoid processes. At this stage, the inferior dental artery may be cut through by the trephine and give rise to troublesome hemorrhage. The disc of bone having been lifted out and the bridge of bone between the condyle and coronoid process clipped through with bone pliers, so as to increase the space in which to work, some loose fatty tissue presents itself, and should be carefully picked away with two pairs of dissecting forceps. The tendon of the temporal muscle is thus more clearly defined, and must be held forward if necessary. Narrow spatulæ are useful at this stage, not only to keep the wound open, but also by their pressure to arrest hemorrhage from divided muscular branches. The inferior dental artery, if still intact, is usually first seen, and may be secured by passing two ligatures around it with an aneurism needle, and dividing it between. The lowest fibres of the external pterygoid muscle are seen running transversely across the wound, and require to be held upward or carefully divided to demonstrate the two nerves passing from behind.

The trunk of the inferior dental nerve can then be raised upon an aneurism needle and the lingual found a little internally and in front; indeed it occasionally happens that the nerves lie in such close proximity to one another that they are picked up together. A silk or catgut ligature may be advantageously passed

around them in order to be able to make traction. It is now easy, by a little manipulation with the handle of a scalpel, to trace them up to the foramen ovale, which can even be seen if the external pterygoid muscle be held well out of the way. The nerves can then be divided close to the skull, either by scissors or knife, and the meningeal artery should be in no danger if the nerves have been sufficiently isolated. Peripheral traction is also employed so as to draw up as much of the nerve as possible, and thus a considerable portion, more than an inch, of the trunks can be readily removed.

REMOVAL OF THE GASSERIAN GANGLION AND INTRACRANIAL NEURECTOMY.—The fact that after the previous operation the pain almost invariably returns, has led surgeons to devise more radical measures for relief, and Mr. Rose and Professor Andrews have resorted to the removal of the Gasserian ganglion. Mr. Rose's operation is as follows:—

An incision is made from near the external angular process of the frontal bone, along the zygoma, then in front of the ear to the angle of the inferior maxilla, and along the lower border of the mandible to the anterior edge of the masseter; this flap is then dissected up without injuring Stenson's duct or the branches of the seventh nerve. The periosteum and temporal fascia are detached from the zygoma, and this is divided at both ends with a saw; previous to dividing the bone, it is drilled for the purpose of inserting wire and holding it in place. The zygoma and the attached masseter muscle are then turned downward, after dividing the fibres of the masseter which arise from the malar bone; the coronoid process of the lower jaw is next divided, and, with the temporal muscle, is raised up. After going through some fat and areolar tissue, the external pterygoid muscle will be exposed; now the internal maxillary artery can be seen and divided between a double ligature. The lower aspect of the great wing of the sphenoid and the outer surface of the external pterygoid plate are then cleared by separating from them the external pterygoid muscle, and the foramen ovale is sought for; this lies a little posterior and external to the base of the external pterygoid plate; the lingual and inferior dental nerves may, of course, aid the surgeon in locating the foramen if they have not been divided by a previous operation. A long-handled trephine with a blunt-pointed centre-pin, which projects in the foramen ovale, is then applied and a disc of bone removed; in his last operation Mr. Rose removed the disc of bone from the great wing of the sphenoid in advance of and outside of the foramen; the trephine opening, which is ½ inch in diameter, may then be enlarged if need be; the proximity of the carotid canal and Eustachian tube should be remembered.

The third division of the trifacial is now traced up to the ganglion, the latter loosened from its bed, and its connection with the brain divided with a hook, sharp upon its concave edge. The opening in the base of the skull is enlarged and the superior maxillary nerve severed in advance of the ganglion; after this the ganglion is scraped or curetted out. The wound is next irrigated and the parts brought into apposition; the coronoid process may be wired to the maxilla, or removed; the zygoma is wired and the external wound sutured.

Mr. Rose's results in this operation have been very encouraging, five patients having remained free from pain after the operation; a sixth, however, died as the result of the treatment. There is great danger of destruction of the eyeball, probably as the result of trophic disturbances; in fact, this accident has occurred in one or two cases.

Andrews, of Chicago, has also removed the ganglion, operating practically in the same way. The incision was in the shape of a letter "H," the vertical limbs being over the ends of the zygoma, and the transverse one along the arch. The trephine opening was ⅝ inch in diameter and was made just outside the oval foramen; a specially con-

structed rongeur was used to connect the two openings, and the ganglion was scraped out with a small sharp spoon. Professor Andrews has operated upon four cases; in two complete relief continued at the end of a year; one patient died from shock.

Hartley, of New York, has performed intracranial neurectomy of the second and third divisions of the fifth nerve by the following method:—

An omega or horseshoe-shaped incision was made with its base at the zygoma, beginning at the external angular process, carried up to the temporal ridge, and ending at about the position of the tragus; after resecting the skin and muscle, the pericranium was divided in the same line; the bone was severed with a grooved chisel, in the upper part the groove in the bone extending through both tables, in the lower part only to the inner table; then, using a periosteal elevator as a lever, the bone was broken on a line corresponding to the base of the incision, and the entire flap was turned downward; after ligation of the middle meningeal artery, the dura was raised with the brain from the middle fossa of the skull, using for this purpose broad, highly polished retractors, and the foramina of exit of the second and third divisions of the nerve were exposed; these nerves were then divided with a tenotome, and the portions between the respective foramina and the ganglion were excised; the cut ends were pushed through the openings so as to separate them as far as possible from the ganglion. The flap was then replaced and the pericranium and scalp sutured. The operation thus consists of an osteoplastic resection. If thought desirable, the ganglion may also be scooped out.

Fedor Krause has operated by a similar method, as have also McBurney (2 cases) and Roberts. In Hartley's case the pain had not returned after 18 months. In all the other cases there has been relief from pain, and, though of course they are too recent to speak definitely as to the value of the operation, there has been no fatal result. Krause in three cases also tore away the entire trifacial root with the Gasserian ganglion.

Horsley says that complete removal of the Gasserian ganglion is impossible without tearing the wall of the cavernous sinus. He therefore determined to divide the nerve behind the ganglion, and operated in the following manner:—

A large flap was raised from the temporal region, the incision beginning at the anterior end of the zygoma, following the temporal ridge, and ending at the junction of the temporal, parietal, and occipital bones; the flap was turned up, and, by trephining and chiselling, the squamous portion of the temporal bone was removed. The dura was then opened, exposing thus the temporo-sphenoidal lobe; the middle meningeal artery was ligated. By means of a broad retractor the brain was carefully raised from the floor of the skull, and the cavity was illuminated by electric light. The dura mater over the nerve was slit open, a hook was inserted, and the nerve was torn away from the pons varolii. The patient thus operated upon, however, died of shock.

The following cases of intracranial neurectomy have occurred in my own practice:—

CASE I.—*Intracranial Neurectomy of the Superior Maxillary Nerve.*—M. S., female, admitted to the German Hospital (private room) March 16, 1894, with the history of having suffered for a number of years from neuralgia of the superior maxillary nerve. The parts supplied by the three terminal branches of this nerve were so sensitive that it required but a slight draft of air upon the surface to excite both pain and spasm. She had had two operations previously (Carno-

chan's) followed by a period of relief lasting a year, when there was a return of the pain. The cicatricial tissue in the line of the original operation was now removed with the hope of affording relief, but while this procedure was followed by some improvement, it was not permanent. The more radical operation of intracranial neurectomy of the affected nerve was then carried out. The steps of the operation consisted in making a semicircular incision over the right temporal region, extending to the bone, which was chiselled through in the line of incision through the soft parts. The bone with its coverings was next turned down as one flap, exposing the dura mater with the anterior branch of the middle meningeal artery. The dura was separated from the middle cerebral fossa, when with the handle of an ordinary table-spoon the brain was lifted up far enough to give a good view of the superior maxillary nerve. Meckel's space was next opened, exposing the Gasserian ganglion, when that portion of the superior maxillary nerve which intervened between the ganglion and the foramen rotundum was excised. The stump of the nerve occupying the site of the foramen rotundum was dislodged by a blunt hook, making the foramen patulous. The osteoplastic flap was now replaced, and the skin wound brought together with interrupted silkworm-gut sutures. Recovery was uneventful. The electric head-light was at first used, but owing to failure of the battery natural light had to be depended upon, and was perfectly satisfactory.

CASE II.—*Intracranial Neurectomy of the Superior and Inferior Maxillary Nerves.*—A. N. F., male, aged 44, was admitted to the German Hospital (private room) July 18, 1894. For several years the patient had suffered from a most obstinate neuralgia of the inferior dental nerve. In the summer of 1892, in the same hospital, I had trephined the inferior maxilla and had excised a portion of the affected nerve; this had been followed by relief for one year, when there was a return of pain referred not only to the distribution of the inferior dental but to that of the superior maxillary nerve as well. On July 20, two days after his admission to the hospital for the second time, I performed intracranial neurectomy of both the superior and inferior maxillary nerves. The *technique* of the operation was the same as that in the case of M. S., with the exception that in this instance two nerves instead of one were excised. The patient was discharged cured on August 3.

Tic convulsif, or *epileptiform tic*, in contradistinction to tic douloureux proper, or trifacial neuralgia, may exist as an independent and painless condition, or may be present as a symptom of the latter affection. The operation for the relief of this form of tic is stretching the facial nerve. One of two methods can be used to expose the nerve, namely, Baum's and Hüter's. In Baum's method, the best, a vertical incision, two and one-half inches in length, is carried behind the ear and parallel with the anterior border of the sterno-mastoid muscle. The posterior border of the parotid gland, the first important structure seen, is displaced forward, when the aponeurosis of the sterno-mastoid is brought into view. The dissection is carried down and between these structures until the layer of fascia covering the prevertebral muscles is exposed, directly in front of which the nerve will be seen closing the space between the mastoid and the vertical ramus of the jaw. Should there be any difficulty in recognizing the nerve, the electric light and the forehead mirror, in addition to the use of the faradic current, will be found of material benefit. The superiority of this method over that of Hüter is, that the scar is hidden by the ears, that the nerve is more readily exposed, and that all of the branches given off beyond the stylo-mastoid foramen are influenced by the stretching. In Hüter's method a vertical incision is carried in front of the ear into the sub-

stance of the parotid gland, until either the cervico-facial or the temporo-facial branch is found, when it is traced back to the main trunk.

Vasomotor and Trophic Nerve Changes.

Angeio-Neurotic Œdema.—Certain vasomotor and trophic disturbances of nerves are deserving of the surgeon's attention; among them are: *Angeio-neurotic œdema* (Quincke and others), or *acute circumscribed œdema*, manifesting itself by the rather sudden appearance of localized œdematous swellings of the skin and subcutaneous tissue, which may subside again in a few hours or less, or may persist for several days. The disease, as a rule, first appears in early life, and Osler and others have observed a seeming hereditary tendency in a number of cases; a more or less distinct periodicity has also been noticed. The hands, feet, lips, eyelids, and genitalia are most commonly affected. The color of the part is usually pale, and the local temperature is somewhat lower than normal; the patient often experiences a burning and tingling sensation, with stiffness, and sometimes pain. The mucous membranes may be affected, and rarely œdema of the larynx has been seen. Vomiting and gastralgia may accompany the attack.

Acromegaly.—In this rare disease there are also trophic changes manifesting themselves by a gradual increase in size of the hands and feet, the bones as well as the soft parts being affected. The nose, chin, and lips also increase in size. The subjective symptoms consist chiefly in general weakness and various neuralgic pains. The exact cause of acromegaly is unknown; enlargement of the pituitary body has been found in a number of cases.

Morvan's Disease.—In this peculiar affection there occur painless whitlows and ulcerations of the fingers, preceded often by neuralgic pains, and accompanied by complete insensibility of the parts and atrophy of the muscles. The lesions of neuritis of the peripheral nerves are found after death, and changes in the gray matter of the cord have been described. Recent investigations seem to show that the disease has a certain relation to syringomyelia.

The disease has been chiefly observed in Brittany.

Raynaud's Disease, or Symmetrical Gangrene.—In this affection there is a "local asphyxia" or contraction of the capillaries of the fingers and hands, supposed to be of neuro-trophic origin and often leading to gangrene. The parts are white and bloodless, there is analgesia, and the local temperature is lowered; subsequently the extremities may become dusky red in color. The disease occurs most commonly in elderly women, and in cases of chlorosis and hysteria, and is met with particularly in winter. Pitres, Vaillard, Affleck, and others have found peripheral neuritis of the affected extremities; syringomyelia and lesions of the brain have also been found after death. The treatment consists in endeavoring to stimulate the circulation by warm baths, friction, and electricity.

ERYTHROMELALGIA.—This disease, first described by Weir Mitchell in 1872, manifests itself by flushing, pain, and local rise of temperature, affecting most often one or more extremities; the symptoms are made much worse when the part is in a dependent position, and when the patient's weight rests upon the limb. It is believed that the lesion consists in a "terminal neuritis." Women are much less often affected than men.

Treatment is unsatisfactory in its results; in a recent case, however, recorded by Weir Mitchell, great improvement followed neurectomy of the musculo-cutaneous and branches of the internal saphenous nerves, and stretching of the plantar nerves; the excised portions of the nerves were found to be absolutely normal.

DISEASES AND INJURIES OF BURSÆ.

BY

CHARLES B. NANCREDE, A.M., M.D.,

PROFESSOR OF SURGERY AND OF CLINICAL SURGERY IN THE UNIVERSITY OF MICHIGAN; PROFESSOR EMERITUS OF GENERAL AND ORTHOPÆDIC SURGERY IN THE PHILADELPHIA POLYCLINIC AND SCHOOL FOR GRADUATES IN MEDICINE.

General Remarks on the Treatment of Bursitis.

While those points will be specifically mentioned in regard to which experience, resulting from the advance in scientific wound treatment, has modified the advice given ten years ago, a few general statements, more or less applicable to all cases, must necessarily preface further remarks. The bursæ being, as previously mentioned,[1] merely enlarged spaces of the connective tissue which is condensed to form their walls, when these sacs become inflamed the process is very prone to extend to the adjacent connective tissue, and thence to all the cellular planes of the part. Even in youth many bursæ open into contiguous joints, while as age advances those which at first did not communicate with an articulation often do so. Before the full confidence which we now feel in aseptic methods was warranted, the following advice, under the heading "Acute Bursitis of the Prepatellar Bursa"[2] was eminently proper: "I would caution against the use of the knife, unless pus is certainly present, as death has thus more than once resulted." Again, the statement that nothing beyond aspiration or subcutaneous discission should be employed in the treatment of deep-seated bursæ, with the absolute prohibition of any cutting operation for the relief of synovial herniæ, requires modification to the effect that these restrictions are now only binding if the strictest asepsis cannot be attained, but that, this being secured, incision and drainage, or complete or partial extirpation, are justifiable.

Treatment of Acute Bursitis.—With the advance in aseptic and antiseptic methods, many of the recommendations formerly given under this caption require additions or modifications. Thus, after the application of leeches, a light antiseptic dressing should be applied to the bites before either dry cold is employed,[3] or evaporating lotions are resorted to, while the latter applications should contain some unirritating but efficient germicide, or germ-inhibitor. Poultices are

[1] See Vol. III., page 135. [2] Ibid., page 161. [3] Ibid., page 138.

only permissible when pus is forming, before an opening is made by nature or art, after which moist antiseptic gauze, covered with rubber tissue or oiled silk, should be substituted. When pus has formed—best determined in all doubtful cases by an aseptic exploring needle or by the aspirator—prompt incision with the strictest aseptic precautions should be adopted, followed by moist antiseptic dressings. The warning given against incisions into inflamed but not suppurating tissues still holds good unless strict asepsis be maintained, because septic infection—local or general—is apt promptly to occur, owing to the diminished resistance of the tissues to microbes, but with the proper precautions no such objection exists, and, on the contrary, incisions will in proper cases relieve, not add to, the existing trouble.

Sinuses will be of infrequent occurrence under antiseptic treatment, but when present should be laid open with the knife where their anatomical relations do not forbid, their tracks being thoroughly curetted, and asepsis secured by solutions of zinc chloride (grs. x to f ʒ i) or mercuric chloride (1–500);[1] when possible, deep or "étage" suturing should be employed, complete rest being insured by a plaster-of-Paris bandage fixing the whole limb; if all these measures cannot be adopted, curetting, disinfection as just advised, and the use of a gradually shortened drainage-tube, its track being effaced by proper compresses, should be tried. The oakum seton formerly advised should be discarded, curetting being preferable.

Treatment of Subacute and Chronic Bursitis.—The only change requisite is a condemnation of any method of employing the seton, except that formed of catgut threads with the strictest of aseptic precautions; horsehair may also be used, but, being non-absorbable, must be removed as soon as it is believed that no more fluid will be effused.

Incised and Punctured Wounds of Bursæ.

With aseptic precautions these may heal without causing obliteration of the bursal cavities. Rest, drainage if deemed requisite, and effective antisepsis are imperative. If either primary or secondary infection occurs, an attempt should be made, under anæsthesia if deemed necessary, to render the parts aseptic, due provision being made by appropriate incisions for the escape of pent-up fluids or those likely to be subsequently effused. When the injured bursa is a deep-seated one, it so often communicates with its related joint that it is safer to consider this to be the fact in any given instance, and to treat the case as one of wounded joint. While all surgeons recognize the evils of the unnecessary use of drainage, still, in the injuries under consideration, the chance of the subsequent infection of an important joint through the medium of a communicating bursa is so great, that after thorough disinfection I certainly think that capillary or in doubtful cases tube drainage is indicated, with absolute fixation of the articulation by suitable splints, or preferably by a plaster-of-Paris bandage. Subsequently, if the joint unquestionably becomes involved, free antiseptic incisions,

[1] If large surfaces are involved, all remainders of such strong solutions should be freely washed away with sterilized water.

the introduction of a sufficient number of drainage-tubes, and fixation of the joint, are imperatively demanded.[1]

Treatment of Bursæ Communicating with Joints, and of Synovial Herniæ.

The positive injunction not to adopt any more active treatment than aspiration of the contents of these sacs, should be modified with our knowledge of the safety of aseptic procedures. Certainly aseptic incision into joints is, in competent hands, a safe operation, so that where the anatomical relations permit, and the disability warrants some slight risk, I do not see why the synovial or bursal sac may not properly be dissected out, either wholly or in part, and the opening through the capsule, when accessible, carefully sutured with fine catgut; indeed the first part of these suggestions has now been successfully adopted in a sufficient number of cases where bursæ have communicated with articulations, to strengthen the opinion here expressed, to which I had independently been led by *a priori* consideration of the subject. Manifestly, when synovial herniæ complicate decided chronic articular disease, as of the knee, an operation for their relief is contra-indicated.

Hemorrhagic Bursitis.

Under this title Lejars[2] has described a chronic condition analogous to pachysynovitis hemorrhagica, where, without traumatism, the contents of a bursa become sanguineous, being blackish, thick, and mixed with yellowish clots. Occasionally pure red blood or clots may occupy the sac; in a recent case of my own, where under my direction my assistant, Dr. Darling, opened a chronically enlarged ilio-psoas bursa, this condition was found. Volkmann has detected in at least one similar case conditions apparently identical with those found in pachymeningitis and in hæmatocele of the tunica vaginalis testis.

Diagnosis.—This can perhaps be made by recognizing during manipulation the crepitation produced by the mutual friction of clots, when these are present, but in most instances incision or puncture first shows that the tumor is not an ordinary chronic enlargement of a bursa.

[1] For the result of temporizing instead of employing the bolder but safer methods advocated, see Lancet, 1880, vol. i., p. 427. Enlargement of semi-membranosus bursa after injury; suppuration extending to knee-joint; aspiration; amputation.

[2] A. J. Silcock reports three cases of disease of the gastrocnemio-semimembranosus bursa, in two of which he dissected the sac free and tied off the pedicle with chromicized gut, in the remaining case merely excising the cyst-wall as far as possible; in all three instances the bursa communicated with the knee-joint. He also mentions a similar case reported by Johnson Smith, but the reference is incorrectly given and I cannot verify it (Brit. Med. Journal, 1889, vol. i. p. 474). H. H. Clutton mentions two bursal tumors closely related respectively to the shoulder and knee joints, viz., the supraspinatus and that under the outer head of the gastrocnemius, which he successfully dissected out, but which he believed did not communicate with the joints. More cases need not be cited in support of the position taken, although many more such could doubtless be found by careful perusal of the literature of the subject.

Recurrence of Chronic Bursal Enlargements after Excision.

Volkmann has reported two cases of this accident after removal of a prepatellar bursa. This is explained, as well as the bilobed form of certain cases of "housemaid's knee," by the long-known fact that the prepatellar bursa is often multilocular, the spaces at times communicating, at others forming separate sacs. Gruber, Luschka, and Linhart have described two or three superimposed sacs in this region which may or may not communicate.

Treatment.—As recurrence has been reported after excisions of the prepatellar bursa only, when the operation is done the dissection should be carried down to the fibrous layer covering the surface of the bone and serving as its periosteum.

Fungous Bursitis.

This disease, incidentally mentioned in the article on Diseases of the Bursæ,[1] has been since proved, by numerous observers,[2] to be tubercular, first by the detection of giant-cells, formerly the only criterion for determining the presence of this disease, but more recently and beyond question by the discovery of the bacillus tuberculosis in certain cases of the malady.[3]

Volkmann first taught the tubercular nature of this disease in 1865, and was followed by Kuester; but it was Charles Nélaton who in 1883 reported a case of Terrier's, clearly proving the correctness of previous teaching.

Tuberculosis of bursæ occurs in two distinct forms, viz.: (1) fungous bursitis, caseous bursitis, or cold abscess of a bursa; and (2) bursitis with riziform or melon-seed bodies.

Caseous Bursitis.—This form of bursitis may develop near either a tubercular tumor or a focus of tuberculous osteo-myelitis, but is more often primitive, being a local tuberculosis of the bursa itself. Brief abstracts of the histories of a few typical cases will best serve to render clear the diagnosis and treatment of this condition.

Terrier had under his care a male patient, aged 29 years, who, without any previous tubercular history, presented a rounded swelling of the size of two fists situated over the inferior angle of the left scapula, beneath which it seemed to extend. The tumor was indolent, soft, fluctuating, non-reducible, and unaffected by coughing. The contents

[1] See Vol. III., p. 144.

[2] Lancereaux, Labbé and Coyne, Trélat, Terrier, Charles Nélaton, Roswell Park, Annals of Surgery, vol. i., p. 241.

[3] Editorial Article, Annals of Surgery, vol. i., pp. 233–256, founded on the following articles: Charvot, Rev. de Chirurg., Mai, Juin, Aout, Sept., 1884, Des Conditions favorables ou défavorables à la tuberculose osseuse; Charpy, Ibid., Sept., 1884, p. 689; Contrib. à l'Étude des Tumeurs blanches et des Abcès froids dans leurs Rapports avec l'Infection Tuberculeuse, Menard, Thèse de Paris, 1884; Tuberculose der Knochen und Gelenke, Prof. Dr. König, S. 170, Berlin, 1884; Ueber chirurgische Tuberculose, Mögling, Mittheilungen aus d. chirurg. Klinik zu Tübingen, Zweites Heft, S. 248, 1884; Ueber Drüsentuberculose und die Wichtigkeit frühzeitiger Operationen, Garré, Deutsche Zeitschrift f. Chir., Bd. xix., Hft. 6, S. 529.

were grumous pus, and Malassez proved by a microscopic examination of a fragment of the cyst-wall its tubercular nature. I have had a case which I believe to be identical with this, but microscopic evidence is lacking. It was operated upon in my presence and at my request, by my assistant, Dr. Darling. Reclus relates the history of an abscess of the subcutaneous bursa over the external malleolus, and believes that certain cold abscesses of the buttock, which are commonly supposed to be of osseous origin, arise in the large serous bursæ of this region.

Demars reports an interesting case of tuberculosis of the bursæ beneath the semitendinosus, sartorius, and gracilis tendons ("*patte d'oie*"), which was at first believed to be a gumma, but which on puncture gave vent only to a yellowish fluid. Palpation now detected crepitation, resulting from the presence of rice-seed bodies, and upon this symptom a diagnosis of tubercular bursitis was founded. Incision confirmed this opinion, the cavity was scraped, and eight days afterwards a cold abscess was discovered amid the muscles of the forearm. Hæmoptysis promptly supervened, and in twenty-five days the patient was dead.

BURSITIS WITH RIZIFORM BODIES.[1]—Nicaise, Poulet, and Vaillard studied the case of a very large bursal tumor of the right thigh, crammed with rice-like bodies to the exclusion of all fluid, in which they for the first time demonstrated the presence of tubercular nodules, containing Koch's bacillus, etc. The tumor followed a blow, was sub-aponeurotic, and gave a sensation of pseudo-fluctuation, making the observer think of that given by a myxo-sarcoma. The same authors report a similar case affecting the bursa over the external malleolus. Probably some of the cases of chronic bursitis described by Volkmann and Fischer, the bursa being lined with a fibrinous coating and often containing numerous melon-seed bodies, were in reality tuberculous.

Diagnosis.—Tubercular bursitis can only be confounded with tertiary syphilitic or simple chronic bursitis, and the peculiarities of the affection given in the histories of the cases here related, together with what has been or will be said of the other conditions, should suffice for the discrimination.

Treatment.—Total ablation, when possible, should always be adopted. If too diffused for a clean dissection, free curetting, irrigation with iodine water, and rubbing into the tissues of iodoform, should be employed, never hesitating to promptly repeat these procedures should any relapse manifest itself.[2]

ANOMALOUS BURSÆ.

Chassaignac has described a rare condition under the name of "*lipomatous hygroma* of the nape of the neck," where a bossellated tumor, composed of fatty tissue with a central cavity, has been met with by him in individuals who carried burdens resting habitually or frequently upon this portion of the body.

[1] These are not identical with those described as occurring in chronic bursitis, the latter not being tubercular, as will be seen by consulting the article in Vol. III.

[2] I am much indebted for many of the foregoing facts to the article by M. Lejars on Diseases and Injuries of the Bursæ; Duplay et Reclus, Traité de Chirurgie, tome i., Paris, 1890.

Many authors, as Berard, Roux, Massot, and others, have related cases where bursæ were developed beneath malignant growths, such as scirrhus of the mamma, sarcoma of the axilla, etc. Broca reports the existence of a bursa upon the inner side of the labium majus, toward its anterior extremity, which, if attacked by suppurative inflammation, gives rise to an abscess differing from those arising in cysts of the vulva or of the vulvo-vaginal gland. So with the submucous hygroma of the anterior portion of the nasal septum, the disease arises in the bursal sac sometimes found here. Chassaignac has also contended that certain marginal anal abscesses originate in the small submucous bursæ not uncommonly present in the anal region.

Tumors of Bursæ.

Exostosis Bursata.—This rare condition was first described by Billroth in 1863. The abstracts of two cases which follow, give briefly all in the way of pathology, diagnosis, prognosis, and treatment which has not been previously given when speaking of bursal diseases in a general way. Rindfleisch contended that this condition had arisen by the growth of an ecchondrosis from the articular cartilage, pushing ahead of it a portion of the articular synovial membrane, the opening into the joint cavity subsequently becoming obliterated. The case reported by Fehleisen to the 14th Congress of the Deutsche Gesellschaft für Chirurgie, held in Berlin in 1885, with cases observed respectively by Volkmann and Erhardt, prove that these growths cannot arise from the epiphyseal cartilages, while the absence of any communication with the knee-joint is regarded by Fehleisen as proving that exostosis bursata cannot arise from the articular cartilage. Fehleisen believes that these growths originate from relics of misplaced fœtal cartilage—in fact, are teratomata of the knee-joint—but Volkmann has pointed out that he has found numerous free cartilages in a case of pseudarthrosis of the femur, and considers that these bursal exostoses arise either from the epiphyseal or articular cartilage according to whether they are within or without the joint. I can see no reason for these recondite theories. Growths from bone may conform to any of the types of the connective tissues: bone, fibrous tissue, cartilage, etc.; certain cases of pseudarthrosis show a cartilaginous coating on the ends of the fragments —nay further, as Volkmann has shown, free cartilages may be present— so that the simplest explanation of exostosis bursata would appear to be that a bony outgrowth, initiated by some irritation or injury, remains partly cartilaginous on its surface, and that over this an adventitious bursa forms with unusually developed fringes, which, undergoing hypertrophy and becoming detached, are then the free cartilages common in this affection.

Case I.—Fehleisen's case, already mentioned, occurred in Bergmann's clinic in the person of a man, aged 43, in whom a painless tumor gradually developed upon the outer side of the left femur until it reached the size of an infant's head. By relaxing the outer portion of the extensor cruris, beneath which the tumor lay, distinct fluctuation was readily detected; in addition, a fixed tumor and several free bodies were recognized. An incision gave exit to much thick, tenacious fluid and 48 free bodies. The adherent capsule was dissected out, no opening

into the joint being discovered, and the bony growth was removed. The capsule was lined with endothelial cells, and two pedunculated bodies hung from the edges of the cartilage-covered exostosis, while around its margins were numerous villi with constricted bases, that is, bodies which when detached would constitute "free cartilages."[1]

CASE II.—A healthy man, aged 20, was admitted in March, 1888, into the Montreal General Hospital, with a tumor located upon the inner side of the femur, which was of nine years' duration, and which when first noticed had been of the size of a marble, and movable. He stated that it had become fixed and firm about four years before. Never painful or tender, during the last few months he had experienced inconvenience in the muscles when going up or down stairs or from overexertion. Upon examination, an apparently pedunculated tumor the "size of a base-ball," with indistinct outlines, was discovered on the inner side of one femur. Upon operation, April 4, 1888, fifty-five free bodies varying in size from that of a pea to that of a large bean were evacuated with much tenacious fluid. The irregular exostosis, covered with a continuous mosaic of cartilage plates, was attached to the "linea aspera below the epiphyseal line by a pedicle one-half inch in diameter and three-fourths of an inch long." The sac, which was dissected out, did not communicate with the knee-joint, but was identical in structure with an articular synovial membrane; the exostosis was also removed.[2]

HYGROMA PROLIFERANS ENDOTHELIALIS.—Morisani reports a case of this rare disease attacking the bursa at the attachment of the tibialis posticus. The wall consisted of two layers, the internal being evidently neoplastic, and presenting microscopic evidences—according to the author—which excluded the idea of its being of either a simple inflammatory, a tubercular, or a sarcomatous nature.[3] The number of cases of neoplasms originating from either bursæ themselves or the scars left after their removal by the knife, is very small. In addition to those mentioned in the article in Vol. III., and one of alleged carcinoma of the bursa beneath the tendo Achillis, mentioned by Platner, I would refer to Von Ranke's article, where he either describes or quotes references to the following cases: Myxoma (sarcomatous ?) of the prepatellar bursa; round-celled sarcoma of the pretibial (?) bursa (mentioned by Ranke as reported by A. Smith, but it is not clearly stated which bursa was involved); sarcoma over the patella[4]; hemorrhagic sarcoma (?) of subquadricipital bursa; angeioma from the scar of an obliterated prepatellar hygroma. Holscher refers in a vague way, in his translation of Brodie on Diseases of the Joints, to hemorrhagic sarcoma originating after treating hygroma by the seton; Schuh's case of cystic hygroma[5] was probably only a relapse of the original condition, viz., hygroma; Dollinger reports a papilloma of the prepatellar bursa originating *from a fistulous track* leading down to an old suppurating bursa;[6] Mikulicz reports a similar instance.[7] These cases show that some communicating track leading to an epithelial-covered surface is a requisite antecedent before an epithelioma-

[1] Archiv f. klin. Chirurg., 1886, Bd. xxxiii, Heft I. (Annals of Surgery, vol. iv., p. 78).
[2] James Bell, Annals of Surgery, vol. ix., p. 112. See also Orlow, Annals of Surgery, vol. xv., p. 400, or Deutsche Zeitschr. für Chirurg., Bd. xxxi., Heft 3, 4. Only ten cases of this rare disease have, as far as I can ascertain, been placed on record.
[3] Progresso Medico; Rivista clinica dell' Universita di Napoli, No. 6, 1890.
[4] Gurlt, Path. Anat. der Gelenkkrankheiten, S. 580.
[5] Path. und Therap. der Pseudoplasmen, 1854, S. 201.
[6] Archiv f. klin. Chirurgie, Bd. xxii., S. 697.
[7] Separat-Abdruck aus den Verhandlungen des XIV. Chirurgen-Congresses, S. 5–19.

tous growth can develop from any bursa, that is, a structure originating solely from connective tissue. Tuffier describes a fibro-myxoma of the ischiatic bursa,[1] and E. Estor a primary sarcoma of the prepatellar bursa.[2] Chavasse reported a case of cystic myxoma of the deep pre-tibial (?) bursa to the Société de Chirurgie.[3] Nicaise has seen two sarcomata of the prepatellar bursa grafted upon old hygromata. One case occurred in the service of Dolbeau, the other was his own.[4] I have myself removed from over both olecranon processes of the same individual, fibro-cartilaginous tumors which arose from the bursæ in this region. From the diversity of these bursal growths and the small number of cases possible to deal with, no useful conclusions can be drawn, while for similar reasons, and because each variety of growth eventually pursues the course of the class to which it belongs, nothing special need be said as to their diagnosis.

BUNION.—When suppuration has taken place in those cases of bunion in which marked deformity of the metatarso-phalangeal joint of the great toe exists (hallux valgus), Riedel has recently in four cases secured a good functional result, the first toe being brought into a fairly normal position, although the remaining toes remained abducted. The bursal sac is carefully excised and the exostoses are removed from the head of the metatarsal bone and base of the phalanx, after which the head of the metatarsal bone is chiselled down until smooth, and of such a form as will admit of an approximate restoration of the member to its normal axis.[5]

[1] Progrès Méd., 1884, tome xii., p. 545.
[2] Gaz. Hebd. de la Soc. Méd. de Montpellier, 1888, tome x., p. 53.
[3] Traité de Chirurgie, tome i., p. 893. [4] Ibid.
[5] Annals of Surgery, vol. v., pp. 162, 163; Centralbl. f. Chirurg., 1886, No. 44.

INJURIES OF BONES.

BY

JOHN H. PACKARD, M.D.,

SURGEON TO THE PENNSYLVANIA HOSPITAL AND TO ST. JOSEPH'S HOSPITAL, PHILADELPHIA.

SINCE the publication of my former article there have been, as will appear in the following pages, very considerable additions to the records of experience in fractures and their treatment. The general adoption of the antiseptic system will be found to have influenced this, as it has all other departments of surgery. Thus in compound fractures, the sterilization of the wound goes far toward setting aside the chief danger, and making a conservative course possible. And any operative procedure, as, for instance, in dealing with failures of union, or with cases where union has taken place with deformity, may be much more safely undertaken. So much has been said and written on this topic, that it need not be further dwelt upon here, especially as it will be referred to occasionally in connection with the fractures of certain bones.

In the arrangement of the subject, the order followed will be in the main that of my former article.

FRAGILITY OF THE BONES.

Some curious cases of fragility of the bones have been reported. Pritchard[1] mentions a child who two days after its birth was found to have fractures of the left humerus and femur; next day the right humerus gave way, from very slight cause, and three weeks afterward the right femur was found to be broken. Union was progressing well at the time of the report. The father had been one of eight children, two of whom had had fractures in infancy; his brother had four children, the first of whom had had a fracture of the arm, the third one of the femur, and the fourth fractures of all four limbs. In every instance the bones had given way spontaneously at or soon after birth.

Graham[2] publishes a letter from a patient (age not stated, nor sex) who says that within his own recollection he had suffered eighteen fractures; his right arm had been broken nine times, his left twice; his right leg twice, his left leg three times; his clavicles once each. Several other fractures had occurred in his early infancy. His father had had broken bones fourteen times; a cousin, twenty-one times (in his case not until advanced life); his grandfather had had a brother who

[1] Lancet, September 1, 1883. [2] Boston Medical and Surgical Journal, May 15, 1884.

was also a "bone-breaker." A boy aged 13, who had had twenty-seven fractures of the bones of his lower extremities, was recently exhibited by Roddick to the Medico-Chirurgical Society of Montreal.[1] The first fracture was of the right femur at 1 year of age. All the earlier fractures had united readily, with abundance of new bone; but not so the more recent ones, and there was a pseudarthrosis at the middle of the left femur. So useless and atrophied were the limbs, that amputation was proposed. The family history was good.

Two cases in which the humerus gave way from very slight cause are reported by Sinclair.[2] One of the patients was a man aged about 30, the other a woman of about the same age. In another instance, recorded by Greenwood,[3] a policeman 30 years old, who "had always been a delicate man," was throwing a cricket-ball, when he felt something snap, and was found to have a fracture in the lower third of the humerus. Berbez[4] saw a girl of 18, the subject of atrophic infantile paralysis of the left arm, which limb had several times been the seat of spontaneous fractures.

Mollities Ossium.

Cases of mollities ossium have been reported by Davies-Colley[5] and by Bennett.[6] Davies-Colley's patient was a rachitic girl aged 13; she had fractures of the left humerus, right femur, and right tibia; all her bones were bent, deformed, and flexible. Bennett's case was that of a woman aged 39, who had had spontaneous fracture of the left clavicle, which united, and then gave way again; one humerus had been repeatedly broken in its upper portion; and the left femur had been fractured. All her bones were much softened, and she suffered greatly from pain. In this instance the disease did not, as has so often been noted in adults, begin in pregnancy.

Almost all the recorded cases of this disorder have been in women. But Rigby[7] saw one in a man aged 43, who had for eight years suffered from what was regarded as rheumatism; his hands and his chest were deformed, and both his femora were bent. Two years before he came under observation he had had a fracture of the right humerus, and then of the right femur, from slight causes. He had none of the constitutional symptoms of rickets. In another instance, reported by Barwise,[8] a man aged 31 had had fractures of the left humerus and femur; he had pains in his muscles and bones, and the latter were bent. Of his five children, the last two, aged 3 years and 1 year respectively, were rachitic, and the elder one had been operated upon for bow-legs.

Fractures in Persons Already Diseased.

In a case reported by Dollinger[9] a man aged 41 was affected with icterus, and had pains in the legs. These pains became concentrated

[1] New York Medical Journal, Oct. 18, 1890.
[2] British Med. Journal, Feb. 1, 1890.
[3] Ibid., Nov. 22, 1890.
[4] Ibid., April 2, 1887.
[5] Transactions of London Pathological Society, 1884.
[6] Lancet, January 16, 1886.
[7] British Med. Journal, July 3, 1886.
[8] Ibid., April 9, 1887.
[9] Centralblatt für Chirurgie, 6 Juni, 1891.

in the right hip, and at length the neck of the femur gave way. On the twenty-fourth day it was exposed and sutured at two points with silver wire; the soft parts were brought together with catgut, and a plaster bandage was applied to the limb. In eight weeks healing was complete, with one dressing; and nine months after operation the patient had good use of the limb, with free movement in every direction.

An instance is recorded by H. Jackson,[1] in which a woman aged 52 was the subject of subcortical disease of the left-leg-centre, the limb being paralyzed; on the twenty-third day the left femur gave way near the trochanters as she was being lifted off the bed-pan. At her death twenty days later there was found cancerous disease of the femur, ovary, and brain.

As to fragility of the bones in disorders of the nervous system, T. Christian[2] asserts his belief that in the case of general paralytics this is a mere coincidence, and not a direct consequence of the disease.[3] Benham[4] reports a case of acute mania in a man aged 54, upon whose death all the left ribs from the 3d to the 7th were found fractured three or four inches from the sternum; they were so softened as almost to break under the finger. Nothing is said as to the state of the rest of the skeleton.

Charpy[5] thinks that fractures may occur in the syphilitic either as the result of a general change in the skeleton as a whole, impairing its power of resistance, or by reason of a local lesion, such as a simple or gummatous osteitis with rarefaction. He found the bones of syphilitics deficient in resisting power, in density, and in weight. One constituent, the fluoride of calcium, was in the bones of such subjects only 1.99 per cent., as against 2.43 per cent. in healthy persons, and 2.92 in the phthisical.

Tavernier[6] gives an account of a married woman who, besides cutaneous syphilides, had nodes on the clavicle and on both humeri; that on the left humerus had been painful for several days, when the bone gave way as she lifted a pillow. Under specific treatment union was complete in three months' time.

Picqué[7] mentions a syphilitic woman aged 57, who had an extra-capsular fracture of the cervix femoris; she had had also a fracture of one tibia, and one of the clavicle, the latter still ununited.

As to cancer, the same author refers to a case in which a woman aged 53 had a fracture of the right humerus, ununited at the end of five months; the left breast had been removed two years before, and the arm had become the seat of the recurrent disease six months after the operation. He quotes from Verneuil the case of a woman aged 35 who had cancer of the breast and of the left femur, when the right femur gave way; death ensued on the seventh day, but at the autopsy no tumor was found at the seat of fracture. He also cites from Desprès two instances in which union took place; and says that this is the rule in osteo-sarcomata but not in carcinomata. W. Roger Williams[8] has

[1] Lancet, March 5, 1887. [2] Journ. of Mental Science, January, 1886.
[3] The same view is taken in an interesting paper by T. Claye Shaw (St. Bartholomew's Hosp. Reports, 1890) as the result of a number of experiments on the cadaver.
[4] Journ. of Mental Science, April, 1885.
[5] Annales de Syphiligraphie et de Dermatologie, 25 Mars, 1887. [6] Ibid.
[7] Gaz. Méd. de Paris, 2 Mai, 1885. [8] Diseases of the Breast, pp. 200 *et seq.*

recorded a number of additional cases of fracture from slight causes in persons affected with breast-cancer; in one the patient was a man aged 45, and the humerus on the diseased side gave way. Polaillon [1] gives two instances in which fracture occurred in femora affected with cancer, and one of fracture in a woman with cancer of the breast.

A number of additional cases of so-called *spontaneous* fracture have been put upon record. Rosenthal [2] mentions that a girl 18 years old, after a nap in a field, had pain in her right thigh and was unable to stand; there was found a transverse fracture in the lower third of the femur, which was put up in plaster of Paris, and united readily. Pantüikhoff [3] saw a young soldier who had had rheumatic pains, and felt intense pain and a cracking in his right leg while at drill; a simple transverse fracture of the tibia was detected; it united in a month's time, but four days afterward the bone gave way again at the same point as he was going down a staircase.

Humphry [4] gives the case of a woman aged 56, who had pain in the right thigh, and in whom the bone gave way in walking; a year later the same thing happened in the opposite limb; after her recovery she had pains in both arms, but nothing further was known of her. Humphry mentions also a case of fracture of the forearm in a child from convulsions in whooping-cough.

Reference is made [5] to the case of a woman aged 26, who for eighteen months had had obscure pains in the upper third of her right arm; she was in the last month of her third pregnancy, when the bone gave way just "at the insertion of the pectoralis major and deltoid muscles." There was still some mobility at the end of two months. Khlamoff thinks that this was perhaps a case of incipient osteomalacia. Poncet [6] gives the history of a man aged 45, who had spontaneous fracture of the left femur; the bone had formerly been the seat of inflammation, which had, however, for sixteen years been apparently cured. Polaillon [7] mentions the case of a man aged 67, ataxic for several years, in whom the tibia gave way at its upper part during a slight movement; no union occurred, bedsores formed, and death ensued on the forty-second day.

Intra-Uterine Fractures.

On this subject an excellent paper has been published by Prof. J. H. Brinton, [8] containing two new cases, and fifty-one collected from various sources. Beck [9] has recorded the case of a girl born with a fracture of the leg united at a right angle, for which a successful osteotomy was performed when she was ten months old. In another instance, reported by Branfoot [10] the mother had been for six weeks under treatment for acute articular rheumatism; her child was born dead, having fractures of both femora and of both bones of each leg;

[1] Statistique et Observations de Chirurgie Hospitalière, p. 289.
[2] London Med. Recorder, July 15, 1886. [3] Ibid.
[4] British Med. Journ., November 15, 1884.
[5] London Med. Recorder, December 15, 1886.
[6] Gaz. Hebdomadaire de Méd. et de Chir., 20 Avril, 1888.
[7] Op cit., p. 144. [8] Trans. of Am. Surgical Association, vol. ii., 1884.
[9] Jahrbuch für Kinderheilkunde, 1886. [10] British Med. Journal, January 21, 1888.

the broken bones were united at right angles, new bone being in each case deposited in the angle. Hofmokl,[1] apropos of a case of united intra-uterine fracture of the thigh observed by him, says that among 117,918 births recorded in fourteen years at the Maternity and Foundling Hospital in Vienna there was not one positively established case of such injury.

Sophus Meyer[2] gives two instances: in one the left femur had been broken about the middle, and the right one was bent, probably from a united fracture; in the other both femora were broken, the right at about the line of the lower epiphysis, the left somewhat higher up; union took place well. In the former case there was suspicion of rachitis, and the mother three weeks before her confinement had struck her abdomen against the corner of a table.

Jones[3] reports a case of intra-uterine fracture of the femur, seen by him when the child was three weeks old; the mother had fallen downstairs when six months pregnant. The left thigh measured 2½ inches in length, the right 4 inches; there was also ¼ inch shortening below the knee. He says that he has seen two other instances, one occurring in the clavicle, the other in the humerus; in neither of these was there any history of injury from without.

An interesting case of multiple intra-uterine fractures has been recorded by Linck,[4] and references are given to eleven other instances.

Of fractures produced during birth, Meyer found in the records of twenty years at the Copenhagen Maternity 13 cases, 5 of the clavicle and 8 of the humerus. He thinks this a small proportion of the actual number, since fractures are apt to be overlooked in dead-born children, and only 2 of these 13 were born dead. In 4 instances (3 of the clavicle and 1 of the humerus) the labors were natural; in the other 9 version was performed. Meyer quotes with disapproval Wehn's suggestion that the bones give way under strong uterine contractions. He says that union is usually perfect in three weeks; callus forms in excess in a few days, but is absorbed, and disappears entirely in a period of some months.

Farnsworth[5] reports a case of fracture of both thighs in delivery of a female child; union was firm on the seventh day, but with lateral curvature requiring correction by splints. Five months afterward there was no trace of the injury.

In a case reported by Wyeth[6] a fracture of the femur at the trochanter, produced by two fingers of the accoucheur in delivering the child, was treated in flexion, with a plaster-of-Paris bandage, and was perfectly united in three weeks, without deformity.

VARIETIES OF FRACTURE.

According to Kroell,[7] a good many so-called oblique fractures are in reality spiral; and he thinks that these, which have been generally de-

[1] Archiv für Kinderheilkunde, Bd. iii.
[2] Schmidt's Jahrb., 1884, No. 1, from Hosp. Tidende, 1883.
[3] Liverpool Med.-Chirurgical Journal, July, 1892.
[4] Archiv für Gynäkologie, Berlin, 1887.
[5] Med. and Surg. Reporter, Sept. 26, 1891.
[6] New York Med. Journal, July 4, 1891.
[7] Deutsche Zeitschrift für Chirurgie, 24 Mai, 1888.

scribed as peculiar to the femur and tibia, but which may also occur in the clavicle, ribs, humerus, and forearm, should be recognized as a distinct class. As a rule they affect the weakest and thinnest portions of the bone. One of their marked features is pain, extending upward and downward, and increased by pressure so as to be unbearable; there is often effusion of blood at the painful spots, and if the injury is near a joint, this is apt to be swollen and tender. Such fractures, Kroell states, are attended with special danger of fat-embolism, of septicæmia, and of gangrene; and when they unite, they do so but slowly.

The subject of fractures penetrating joints has been ably discussed by Oberst.[1] He says that these injuries are too apt to be followed by anchylosis. Such a result may be due either (1) to too prolonged confinement of the joint at rest; (2) to inflammatory processes from traumatism; (3) to excessive deposits of callus; or (4) to intra-articular and extra-articular extravasation of blood. On the other hand, abnormal mobility, with weakness and instability, may be the consequence of too prolonged rest. Either of these conditions will generally yield to massage and passive motion, or may subside spontaneously with time. The indications for treatment are clear: withdrawal of blood by puncture, if necessary; even and methodical compression, if this will serve to cause absorption, and subsequently a merely retentive bandage; and massage, with careful and painless passive motion, from the first.

Fractures in Aged Persons.

Humphry[2] has collected 19 cases of this kind, the oldest patient having reached the age of 100, while the youngest was 68; the average being a trifle over 80. In two of these, a man aged 86 and a woman aged 68, a fatal result ensued; in the remainder, or nearly 90 per cent., good union was obtained.

One of these cases, reported by Groom,[3] was that of a woman 81 years of age, who sustained a fracture of the femur and a luxation of the shoulder; in six weeks she was able to walk with a stick, and at the end of five months she walked a distance of four miles.

Conditions Attending and Consequent upon Fractures.

According to Verchère,[4] phosphaturia and polyuria are apt to attend fractures, as well as other lesions of bone; he cites cases in which the former condition seemed to have predisposed to fracture, but not to have impeded union. Sometimes, however, it has delayed consolidation. The influence it exerts is not yet clearly defined.

Grossich[5] has noted a rise of temperature in cases of fracture, and in other lesions and operations affecting the bones; his observations confirm those of Stickler, formerly quoted. He has also remarked an

[1] Schmidt's Jahrb., 15 Juli, 1888, from von Volkmann's Samml. klin. Vorträge, No. 311, 1888.
[2] Brit. Med. Journ., July 12, 1884.
[3] Lancet, April 12, 1884.
[4] Gaz. Méd. de Paris, 26 Sept., 1885.
[5] Med. Times (London), June 6, 1885.

increased amount of indican in the urine under such conditions, but this does not perhaps possess any practical significance.

In an article [1] on the occurrence of sudden death after fractures, Bruns mentions the case of a woman aged 55, who broke her right femur; on the fifteenth day the limb became œdematous; ten days afterward she died after a brief attack of precordial anguish; an autopsy showed blocking of the pulmonary artery and of other vessels. He has collected 35 cases of thrombosis in the neighborhood of fractures, in 23 of which sudden death occurred. The third and fourth weeks would seem to be the usual period of danger from this source. Bruns thinks that there may be many such cases, but of slighter severity, which end in recovery.

Tumors Developed at the Seat of Fracture.

In a case recently seen by Professor Ashhurst and myself, in consultation with Professor Brinton, a gentleman aged 58 had, apparently as the result of a fracture of the head and anatomical neck of the right humerus, a central sarcoma of that bone. He had also a well-marked hypertrophic deforming osteitis of the right femur. Amputation at the shoulder was performed by Professor Brinton, the only difficulty encountered being the necessity of tying a very large number of vessels. The patient did well for a week, when a rubeoloid dermatitis broke out over the body and limbs, with high fever; death ensued at the end of forty-eight hours.

Deakin [2] has reported a case in which a young man sustained a double fracture of the humerus, in which, six months afterward, a myeloid tumor was developed, causing complete absorption of the shaft of the bone; the growth was excised, but death took place from exhaustion on the next day.

Eustace [3] met with a case in which after a fracture of the femur there was a formation of hydatids, and refracture a year subsequently; amputation through the hip-joint was performed, but with a fatal result.

Phelps [4] mentions the case of "an old man" who had broken his humerus forty years before, and presented a large tumor developed at the back of the arm at about the seat of fracture.

Treatment of Fractures.

As to the general treatment of fractures, Lucas-Championnière [5] advocates the employment of massage and mobilization. By this method, proposed by him in 1886, he claims that the formation of callus is favored and regulated. He regards the exact restoration of the shape of the limb as of less consequence to function than the preservation of muscular tone, the suppling of the joints, and the prevention or relief of pain.

[1] Gaz. Méd. de Paris, 22 Mai, 1886.
[2] Am. Journal of the Med. Sciences, April, 1884.
[3] Brit. Med. Journal, May 26, 1894.
[4] Med. Record, December 1, 1888.
[5] Journal de Médecine et de Chirurgie Pratiques, Déc., 1889.

Similar views have been expressed by Franks.[1] I do not think that they have met with any favor in this country, except in the later stages of treatment; yet I think that with certain limitations they might well be accorded some weight. My own belief in the value of early passive motion has been more and more confirmed by experience, and along with this it is very easy to combine kneading of the muscles, and such gentle friction of the skin as may render the circulation more active. To very many patients such manipulations are productive of much comfort. Especially in fractures near joints, I believe that rigid confinement is a frequent source of long-continued if not permanent lameness and stiffening.

Local anæsthesia by means of hypodermic injections of cocaine is recommended by Conway[2] as an aid in the examination of fractures and luxations. Divided doses up to 10 or 15 minims of the usual four-per-cent. solution are used, the circulation being checked by an elastic band around the limb above the seat of injury.

The treatment of *compound fractures* has, as a matter of course, been greatly modified by the modern method of dealing with all open wounds. The thorough cleansing and sterilization—rendering aseptic—of every portion of the exposed tissues, and the application of aseptic protective dressings, are the essential features of the system. Complete discussion of the details of such procedures, and of the results obtained, may be found in articles by Dennis,[3] Davies-Colley,[4] and Burrell and Dwight.[5]

Senn has proposed[6] to fix the fragments together by the use either of an aseptic perforated bone tube, inserted into the medullary canal, or of a ferrule or ring of the same material surrounding them. He cites three instances in which he tried the latter plan, but not with very good results; and there are certain difficulties in its application, which it would seem must limit its employment to exceptional cases.

Non-Union and False Joint.

For the mechanical restraint of the exposed ends of the fragments in ununited fractures, Estes[7] recommends a device somewhat similar to one long in use, and generally credited to Langenbeck. He employs a steel plate three-eighths of an inch wide, one-sixteenth of an inch thick, and two and one-half inches long, and with several holes drilled through it on either side of the mid-point. This is applied directly to the fractured bone, so that it may be secured to the fragments by driving ivory pegs through the holes into corresponding holes bored into the bone. The ends of the pegs are left long, so that they project through the linear wound, and can be withdrawn after about three weeks, when the plate is removed also. According to Estes, this plan has answered very well

[1] Dublin Journal of Med. Science, Nov. 2, 1891. Other articles on this subject have been published by Rosenblith, in the Journal de Médecine de Paris, for March 21, 1891; by Landerer, in the Centralbl. für die gesammtliche Therapie, for June, 1891; and by Huyberechts, in La Presse Méd. Belge, for Nov. 16, 1891.

[2] New York Med. Journal, Dec. 5, 1885.

[3] Journal of the Am. Med. Association, June 21, 1884.

[4] Guy's Hospital Reports, vol. xxix., 1887.

[5] Boston Med. and Surg. Journal, Sept. 8, 1892.

[6] Trans. Am. Surgical Association, vol. xi., 1893.

[7] Trans. Med. Soc. of Pa., 1892.

in 18 cases. He refers to Schede's use of a similar method, but with a plate made of aluminium. He observes the strictest antiseptic precautions, and employs a plaster-of-Paris splint to keep the limb immovable. Good results have been obtained by Halsted, of Baltimore, by the application of silver splints to the fragments, closing the wound over them, and allowing them to remain permanently in place.

As to the general treatment of failure of union Del Vaille[1] records good results from the administration of phosphide of zinc, $\frac{1}{8}$ to $\frac{1}{4}$ grain daily. He first experimented with it on animals, and then used it on eighteen patients, all of whom made exceptionally rapid recoveries.

Stocks[2] treated a boy aged 10, with an ununited fracture of the leg, operated on without success three years previously; he gave him for a month a diet of meat and milk, with strychnia and superphosphate of iron; another operation was then performed, and in three months perfect union was obtained.

By Ménard,[3] a ten-per-cent. solution of chloride of zinc has been injected between the fragments of a tibia and fibula, ununited after five months of treatment, in a man aged 43; one month afterward, consolidation was complete, and the patient was able to walk.

Moore[4] speaks highly of glacial acetic acid, which he says has for many years past been used in cases of non-union at the Melbourne Hospital.

Two cases have been reported in which portions of the femora of rabbits have been transplanted successfully for the relief of ununited fractures of the bones of the forearm. In one, by McGill,[5] a young man of 20 had non-union of the radius; an incision was made and thirteen pieces of the femur of a 6-weeks-old rabbit were inserted; on the tenth day the wound was examined and found almost healed; on the fortieth the man was discharged with perfect union. The other case was recorded by Sherwood;[6] both bones were involved, and the forearm and hand were atrophied and useless. The ends of the fragments were excised, and nine pieces of a rabbit's femur were wedged in; some suppuration ensued, and four pieces came away, but about four months afterward union was sound. Nothing is said as to the ultimate usefulness of the hand.

Brief reference may be made to an extraordinary attempt of Phelps[7] to engraft the bone of a living dog's leg directly into that of a boy, for the relief of an ununited fracture. The ends of the fragments were excised; the dog's bone, separated, but still connected with its nutrient artery, was fastened in place, and boy and dog, bound together, were placed in bed. At the end of ten days the experiment was abandoned as a failure.

Fractures of the Bones of the Face.

A case which came under my care in 1892 seems to me worthy of record here. A boy, aged 15, was brought in to the Pennsylvania Hospital, having sustained a "smash" of the face by the bursting of an

[1] Lancet, Sept. 27, 1890. [2] Manchester Medical and Surgical Reports, 1870.
[3] Revue de Chirurgie, 10 Mai, 1892. [4] Australian Med. Journal, Aug. 15, 1892.
[5] Lancet, Oct. 26, 1889. [6] Med. Record, Sept. 13, 1890. [7] Med. Mirror, April, 1891.

emery wheel. I was trying to get the fragments in place, when his respiration ceased, and it was evident that blood had run down into the air-passages. I instantly performed tracheotomy, and a large amount of blood, partly clotted, was evacuated through the wound. Perfect recovery ensued.

Fractures of the Laryngeal Apparatus.

Lane[1] found in a woman aged 80, a subject in the dissecting-room, the cornua of the hyoid bone separated from the body of the bone; the left greater cornu had been obliquely fractured, and united by fibrous tissue; the thyroid cartilage was deformed, its angle widened out, and its alæ bent so that their posterior surfaces looked inward. The injury was thought to have been caused by a blow on the neck.

Berry[2] reports the case of a man aged 21, struck by a piece of wood thrown off by a circular saw; there was no spitting of blood, but he died from asphyxia in about twelve hours. At the autopsy the wings of the thyroid cartilage were found to be separated and splintered, the angle of one being broken off.

Devernine[3] saw in 1887 a young man aged 24, who nine years previously had struck on his throat upon a trapeze-bar, sustaining a fracture in the middle line of the thyroid and cricoid cartilages, and of the upper four rings of the trachea. Union had taken place well, but the patient was suffering from phthisis, which proved fatal in the following year.

In a case reported by Sokolovski,[4] a woman was struck across the throat by "the strap of a mill," and had a fracture of the thyroid cartilage and of both sides of the cricoid. Tracheotomy was performed on the second day; pieces of necrosed cartilage came away in the fourth week, and a month later both halves of the thyroid cartilage were removed. The patient made a good recovery.

Other cases of severe injuries of the larynx are reported by Knaggs,[5] by Manby,[6] and by Jeanmaire.[7]

Deakin[8] states that in fourteen cases of judicial hanging in India he found, as a rule, either rupture of the epiglottis or fracture of the hyoid bone or laryngeal cartilages.

Fractures of the Ribs, Costal Cartilages, and Sternum.

The first rib alone has been seen fractured in two cases by Lane.[9] In one, union had failed to occur. Another instance is reported by Marsh,[10] who cites three additional cases, and thinks that in all the mechanism was direct violence applied through the clavicle. In a case given by Messiter,[11] a man aged 70 was run over by a cart, and died of shock; the sternal end of the right clavicle was luxated

[1] Trans. of Pathological Society of London, 1884.
[2] Lancet, May 23, 1885.
[3] British Medical Journal, May 24, 1890.
[4] Lancet, June 8, 1889.
[5] Brit. Med. Journal, Nov. 8, 1884.
[6] Lancet, Jan. 9, 1886.
[7] Arch. de Méd. et de Pharm. Militaires, 1890.
[8] Lancet, Jan. 5, 1884.
[9] Brit. Med. Journ., Jan. 10, 1885.
[10] Lancet, June 30, 1888.
[11] Brit. Med. Journal, Feb. 19, 1887.

forward, and the first rib broken where the artery crossed over it; the second rib was broken at its mid-point, and the third and fourth behind their angles, wounding the lung. Here the above-mentioned explanation seems clearly applicable. I have lately had under my care at the Pennsylvania Hospital a man aged 21, in whom the impact of a wagon-pole had driven the cartilage of the left third rib directly backward, separating it from its connections. The only symptoms were those of shock; and perfect recovery ensued, but with the fragment in its abnormal position.

Lane [1] found in a dissecting-room subject, a man aged 56, fractures of the seventh rib (incompletely united), of the eighth (the inner wall only), and of the ninth (the outer wall only).

Several new cases of fractures of ribs by muscular action have been put upon record: from sneezing (eighth right rib) by Wyman; [2] from coughing (second left rib) by Brown, [3] (eighth left rib) by Masser, [4] (place not stated) by Desnos, [5] in a man aged 30, an asthmatic, and in a man aged 60, the subject of bronchitis; [6] from vomiting (ninth right rib), in a woman aged 31, by Hawley; [7] from missing in making a hammer-blow, in a very strong man aged 54, by Underhill; [8] in this last case three ribs, the sixth, seventh and eighth of the left side, gave way.

In one curious case reported by Bird, [9] a lady made a great effort in lifting, and fracture of the second left rib took place. Apropos of two other instances, observed by himself and Dr. E. Martin, Tunis [10] has given a very good *résumé* of the literature of this subject.

Annandale [11] has reported the case of a man aged 29, who by an explosion sustained a compound comminuted fracture of the tenth and eleventh ribs on the left side, wounding the spleen and pleura; pericarditis supervened, for which paracentesis was performed, but death ensued on the thirteenth day.

Other instances of fractured ribs have been recorded by Cantlie, [12] by Neal, [13] and by Sheild. [14] In the last-mentioned case, a man aged 47 was crushed against a wall by a wagon-pole, and had fracture of the third and fourth left ribs, with complete rupture of the left bronchus. Rolleston [15] reports three cases of extensive and fatal crushes of the chest, in one of which the right bronchus was torn entirely across, and the lung wounded; in another there was fracture of the scapula, and rupture of the spleen and left kidney. In all, the first and several other ribs were broken.

Barth [16] saw a case in which a man aged 46 died suddenly on the ninth day after sustaining a fracture of the sixth right rib by direct violence; the pleura was found to have been torn, and an enormous effusion of blood had occurred from a ruptured intercostal artery.

[1] Trans. of Pathological Society of London, 1884.
[2] Journ. of Am. Med. Association, Nov. 7, 1885.
[3] Indian Med. Record, Dec. 1, 1890.
[4] Brit. Med. Journal, April 26, 1890.
[5] La France Médicale, 20 Oct., 1885.
[6] Another case, also from coughing, in a man aged 60, a heavy drinker, is reported in the British Medical Journal for July 5, 1894, over the signature "B. S." Crepitus is said to have been felt "over several of the lowest ribs."
[7] Medical Standard, May, 1890.
[8] Lancet, June 28, 1864.
[9] Australian Med. Journal, May 15, 1889.
[10] University Med. Magazine, Nov., 1890.
[11] British Med. Journal, Jan. 3, 1885.
[12] Ibid., March 9, 1889.
[13] Ibid., March 23, 1889.
[14] Ibid.
[15] Trans. of Path. Society of London, 1891.
[16] La France Méd., 18 Déc., 1888.

In a case reported by Gill,[1] a man about 50 years old fell, while drunk, a distance of twenty feet; he had a simple fracture of the ninth and tenth right ribs, and a fracture of the sternum just below the junction of the first and second portions; the pleura was wounded, causing emphysema; he suffered from profound shock, but recovered, fibrous union taking place. A very similar case, the fracture being, however, at the junction of the second and third portions, with an angular projection forward, is recorded by Eames;[2] the result is not stated. Bennett[3] reports the case of a man crushed against a wall, who had a fracture of the sternum running downward and backward, beginning in front at the level of the cartilages of the second ribs, and ending below that of the cartilages of the third pair; the second and third ribs were broken on both sides, and on the right the fourth and fifth also; the trachea was ruptured transversely, its upper and lower portions being an inch apart.

Porter[4] gives a case in which a young man of 21 had a separation, apparently epiphyseal, between the second and third pieces of the gladiolus, the lower overriding the upper. Lyman[5] saw the gladiolus driven backward from the manubrium, the second rib on each side remaining attached to the latter. In both the cause was direct violence; in both reduction failed, but took place spontaneously in the act of coughing. Another case, successfully treated with a plaster bandage, is reported by Cale.[6]

I have recently had under my care at the Pennsylvania Hospital a man, aged 60, who had fallen a distance of three stories, sustaining a fracture of the right upper angle of the manubrium and of two or three ribs; the right tibia was also broken in its upper fifth. There was very marked shock, and next day emphysema, which extended up the neck and across to the left side. For about two weeks he lay in a stupor; then he improved very much, but a week later became delirious, especially at night. This condition gradually subsided; about the sixth week he was out of bed, and at the end of nine weeks he was discharged well.

Fractures of the Clavicle.

Cathcart[7] calls attention to the fact that the weight of the upper limb is supported by the trapezius muscle, acting through the clavicle, which is a lever with its fulcrum at the sterno-clavicular joint. He cites in evidence of this some observations by Duchenne and by Cleland in cases of paralysis of that muscle. When the lever is broken, the limb tends to fall inward and downward.

I may say that further experience has confirmed my belief in the correctness of the theory which I have formerly maintained as to the action of the serratus magnus and pectoralis minor in producing the displacement in these injuries. I have repeatedly demonstrated it to my classes at the Pennsylvania Hospital, and have shown the good results of treatment based thereupon.

[1] New Orleans Med. and Surg. Journal, Oct., 1885.
[2] British Medical Journal, Nov. 20, 1886.
[3] Ibid., March 10, 1888.
[4] Boston Med. and Surg. Journal, April 12, 1888.
[5] Ibid.
[6] International Journal of Surgery, August, 1890.
[7] Brit. Med. Journal, Aug. 30, 1884.

McKee [1] has recorded a case of fracture of the right clavicle 2¼ inches from the middle of the supra-sternal notch, by muscular action, in a man aged 49, who was trying to lift a heavy weight. A false joint had formed, but no treatment was instituted.

Köhler [2] met with a case in which, among other fractures, there was one near the sternal end of the clavicle, which was itself luxated upward; the short inner fragment was drawn upward by the sterno-cleido-mastoid muscle, so that its broken end was close to the edge of the jaw.

A case is recorded by Bennett [3] in which a young man aged 19, crushed under a mass of masonry, had in one clavicle two fractures, a complete one at the sternal end, and an incomplete one at the middle.

Compound fracture of this bone is reported by Russell;[4] cases of non-union, successfully treated by resection and wiring, are recorded by Barker [5] in a boy of 12, by Pollard [6] in a girl 16½ months old, and by Powers.[7] In this last case, that of a man aged 29, the deltoid muscle was atrophied; abduction was limited, and rotation, flexion, and extension were practically lost. The fragments having been wired together by Bull, complete union ensued, and the functions were almost entirely restored under massage, faradization, and exercise.

In an instance reported by Twynam,[8] a young girl was thrown from a horse, and sustained a fracture of the right clavicle; five days afterward an aneurismal swelling was noted, became very large, and on the 31st day was treated by operation. An incision was made in the median line, and a ligature was placed on the innominate, supposed to be the carotid, which latter vessel was afterward found and tied. Death ensued in eighteen hours, preceded by coma, and by paralysis of the left side of the face and right side of the chest. It seemed probable that there was pressure on the phrenic nerve, as well as cerebral embolism.

A case is recorded [9] in which, in a girl aged 8, a bandage and axillary pad were applied on the third day, and gangrene ensued by the seventh, necessitating amputation ten days subsequently. A suit for damages, brought against the surgeon, fell through because of the proof of negligence on the part of the parents of the child; but the costs were divided.

In an article [10] on nervous disturbances consecutive upon fractures of the clavicle by indirect violence, Chavier asserts that these may result from an ascending neuritis set up by contusion of the nerves, independently of any irritation by splinters, by callus, or by the pressure of apparatus.

Cases of fracture of both clavicles simultaneously have been recorded by Bennett,[11] in a girl aged 6 years; in adults, by J. Wm. White,[12] by Owen,[13] by Page,[14] and by Boger.[15] Good results were obtained in all these cases except Bennett's, in which other injuries proved fatal, and Boger's, in which the patient was intractable.

[1] Occidental Medical Times, March, 1890.
[2] Berliner klin. Wochenschrift, 1886, No. 33. [3] British Med. Journal, Nov. 24, 1883.
[4] Ibid., May 16, 1885. [5] Ibid., Jan. 30, 1886. [6] Ibid., March 26, 1887.
[7] New York Medical Journal, May 24, 1890. [8] Lancet, June 21, 1890.
[9] British Med. Journal, May 29, 1886. [10] Gaz. Médicale de Paris, 24 Août, 1889.
[11] Lancet, Jan. 22, 1887. [12] University Medical Magazine, Jan., 1890.
[13] Lancet, July 5, 1890. [14] Ibid., July 12, 1890. [15] Ibid., July 26, 1890.

Fractures of the Scapula.

Two additional cases in which this lesion was due to muscular action have been reported: one by Dobson,[1] and the other by Leidy.[2]

R. W. Parker[3] has recorded three cases affecting the neck of the bone, two in men aged 55 and 68 respectively, and one in a woman aged 44; in another case, that of a man aged 24, the injury appeared to be a contusion merely, followed by wasting of the neighboring muscles, but the diagnosis was at first obscure. Another instance, in which the injury at first seemed to be a luxation of the humerus, has been reported by Hemenway.[4]

I had myself in 1887, at the Pennsylvania Hospital, a boy said to be two years old, but very large for that age, who had fallen out of a third-story window, sustaining a fracture in the shoulder-joint, probably through the glenoid cavity; the crepitus was very distinct, but could not be certainly located. On the sixteenth day all trace of the injury had disappeared.

In a case reported by S. C. Smith,[5] a man aged 35 sustained by a crushing force a fracture of the scapula and upper three ribs on the left side, with rupture of the subclavian artery and vein; death ensued in sixteen hours, from shock.

Robson[6] saw a miner, aged 31, who had had a fracture of the scapula by direct violence; there was a gap of an inch between the two portions of the spine near the root of the acromion, and the muscles were wasted. The fragments were exposed, freshened, and wired together, and five months afterward the strength and movements of the part were completely restored.

Cases of fracture of the *coracoid process* have been reported by Huse,[7] Bennett,[8] Gabb,[9] Morgan,[10] Young,[11] Greene,[12] Field,[13] and Hupp.[14] Field's case was that of a boy only 5 years old, and it seems to me to be perhaps open to some doubt, on account of the extremely small size of the process at that early age. Yet in Bennett's case, and in one seen by Durham,[15] the former in a boy of 6, and the latter in a boy of 12, the diagnosis was verified by dissection after death. In Durham's case there was no history of injury, and nearly the whole of the scapula was lying bare in an abscess, which had involved the shoulder-joint; the assumption that "the probable sequence of events was a blow on the coracoid process with partial or entire separation, followed by acute inflammation and formation of pus," seems to me therefore scarcely warranted. I am more inclined to believe that the epiphysis was bathed in pus, and separated by maceration.

[1] Lancet, Nov. 27, 1886. [2] University Medical Magazine, March, 1891.
[3] British Med. Journal, Aug. 22, 1885.
[4] Journal of the Am. Med. Association, Feb. 5, 1887.
[5] Lancet, Jan. 24, 1891. [6] British Med. Journal, Nov. 1, 1884.
[7] Chicago Med. Journal and Examiner, Aug., 1879.
[8] British Med. Journal, Nov. 24, 1883. [9] Ibid , Nov. 30, 1889.
[10] Ibid., Dec. 14, 1889. [11] Ibid., Dec. 21, 1889.
[12] Ibid., Jan. 25, 1890. [13] Boston Med. and Surg. Journal, April 24, 1890.
[14] New York Medical Journal, Dec. 10, 1892.
[15] Mentioned by Tubby, Guy's Hospital Reports, 1889, p. 270. This paper contains a very interesting discussion of the subject of traumatic separations of the epiphyses of the upper extremity.

Fractures of the Pelvis.[1]

A case of separation of the right anterior superior spine of the ilium by muscular action has been recorded by Brown;[2] the patient, a boy aged 17, recovered completely in eight weeks. In another instance, reported by Nickerson,[3] the boy walked without crutches in three weeks. In Joy's case,[4] a good recovery ensued in two weeks. In two other cases, reported by Hyde[5] and by Sealy,[6] the injury was in the nature of a sprain-fracture, the anterior inferior spine being torn off by the pull of the head of the rectus muscle attached to it.

A case of fracture of the pelvis on either side of the symphysis pubis, with rupture of the urethra and extravasation of urine, followed by repeated attacks of retention, and by the formation of perineal fistulæ, but ending in recovery, has been recorded by Dunn.[7] In another instance, reported by J. B. Deaver,[8] a fracture at one side of the pubic arch, in a boy 3 years old, gave rise to a urethro-rectal fistula which persisted twenty-one years, and was then closed by a plastic operation. Battle,[9] in the case of a girl aged two and a half years, with compound fracture of the left side of the pelvis through the transverse and ascending rami of the os pubis, close to the symphysis, and with separation of the sacro-iliac synchondrosis, made an incision in the groin, and wired together the fragments, which were separated one and a half inches. Perfect recovery ensued.

In a case reported by Browne[10] the epigastric artery, and in one by Mason[11] the obturator artery, was torn across; in both the bladder and urethra were ruptured; death took place in the former in four hours, in the latter not until the seventeenth day.

Allis[12] argues that in considering the injuries of the pelvis, it should be regarded as a bony ring, and not as composed of its several parts. He thinks that when the anterior portion suffers, the urethra is torn across, not cut by fragments; and that the vessels are similarly dragged upon when there is expansion of the posterior part of the ring by violence from without.

Holmes[13] met with a case in which a man fell fifteen feet, striking on the greater trochanter, and died in a few hours; the head of the femur was found to have been driven through the fractured acetabulum into the pelvis. I have myself recently had in the Pennsylvania Hospital a man aged 54, who fell a considerable distance, and fractured the lip of the acetabulum, allowing the head of the femur to slip up upon the dorsum ilii. After reduction shortening was noticed, easily overcome, with crepitus, and as easily recurring; extension was carefully and

[1] The reader is referred to an interesting article by Kloos, "Zur Casuistik der Beckenfracturen" (in Beiträge zur klinischen Chirurgie, 1888, Band iii., Heft 3). The author gives 4 cases, 3 fatal, the autopsies showing injuries either of the bladder or of the urethra.

[2] British Med. Journal, Aug. 16, 1884.

[3] Boston Med. and Surg. Journal, March 6, 1890.

[4] Canada Med. Journal, Aug., 1870.

[5] British Med. Journal, Nov. 2, 1872.

[6] Ibid., Nov. 16, 1872.

[7] Guy's Hosp. Reports, vol. xxix., 1887.

[8] Trans. of Am. Surgical Association, vol. x., 1892.

[9] Trans. of the Clinical Society of London, vol. xxvii., 1894.

[10] Lancet, May 15, 1886.

[11] Ibid., Jan. 22, 1887.

[12] Trans. of Am. Surg. Association, vol. viii., 1890.

[13] British Med. Journal, Dec. 24, 1887.

continuously applied, and at the end of about three months the man was discharged, walking well, and with the limb apparently of normal length.

In an instance reported by Bull,[1] a man aged 30 fell through a hatchway, sustaining a compound fracture of the innominate bone, opening the hip-joint; he recovered with a useful limb.

I have recently had at the Pennsylvania Hospital a case in which suppuration occurred about a fragment, comminuted fracture of the ilium having taken place ten years before; healing took place promptly after the splinter had been removed.

Pollock[2] gives a case in which a man aged 55, run over by an engine, had a fracture of the pelvis, and a spicula of bone wounded the left internal iliac artery, causing his death in seven hours; he had also two or three upper ribs broken. Sir Charles Bell[3] mentions an Irish laborer who fell from a height, injuring his right hip; a swelling ensued, extending from the lower ribs half-way down the thigh; on incision, blood only flowed, and after death it was found that there was a fracture into the sciatic notch, the gluteal artery being wounded, with formation of a false aneurism.

A fracture of the sacrum is reported by Hirst.[4] A woman, aged 32, with six children, the youngest being 3 years old, had fallen three stories, striking on the sacrum. When seen by Hirst, it was found that the bone had been broken transversely at the level of the posterior inferior spinous processes, and that the fragments had united at an angle 90 degrees salient forward; the outlet of the pelvis was reduced to 1½ inches in its antero-posterior diameter.

Fractures of the Humerus.

Pollosson[5] has reported a case in which a woman died after suffering severely with eclampsia, and the head of each humerus was found to present a deep indentation apparently made by the anterior edge of the glenoid cavity; the cancellous structure beneath was infiltrated with blood.

A number of cases of separation of the upper epiphysis have been put upon record. Tubby, in the paper before referred to, cites an instance in a boy aged 14, under the care of Mr. Durham, and another in a girl aged 17, a patient of Mr. Davies-Colley; in both the cause was direct violence, and a good result was obtained. Rollet[6] reports two cases of Poncet's. In one, that of a girl aged 15, the projecting edge of the lower or shaft fragment was resected on the thirty-ninth day; in the other, that of a boy aged 17, the operation was performed on the forty-first day; perfect union was obtained in both. Knox,[7] in the case of a boy aged 16, where the end of the diaphysis protruded through the deltoid muscle, effected reduction, applied an antiseptic dressing, a felt shoulder-cap, and an inside angular splint; complete recovery ensued. Clark,[8] in a similar case, was obliged to amputate, the limb becoming gangrenous from injury to the axillary artery.

[1] New York Med. Journal, Jan. 17, 1885.
[2] British Med. Journal, March 14, 1885.
[3] Principles of Surgery (1826), vol. i., p. 383.
[4] Boston Med. and Surg. Journal, Jan. 5, 1893.
[5] Revue de Chirurgie, Nov., 1888.
[6] Lyon Médical, 29 Mars, 1891.
[7] Medical News, Dec. 5, 1885.
[8] Glasgow Medical Journal, Sept., 1886.

Detachment of this epiphysis has sometimes been followed by failure of development of the bone. Such cases have been recorded by Bruns,[1] by Bryant,[2] and by Shearar.[3]

As to the treatment of ordinary cases, enough has already been said. Besides the operations above referred to, Helferich,[4] in a successful case shown to the Society of German Surgeons, cut down upon the fracture, reduced the displacement, and secured the fragments by passing through them a long steel pin, which was left in place for two weeks. Bruns stated that in two instances he had excised the detached epiphysis, and Wölfler had had one like experience.

Todd[5] reports a case in which an old woman who had fallen down a flight of stairs, was thought to have sustained a fracture of the anatomical neck of each humerus. In another case, recorded by Croft,[6] a man aged 33 fell about eighteen feet, breaking the neck of the bone, and displacing its head into the axilla, whence it was excised; the result is said to have been better than might have been expected. Poirier[7] has reported another instance. Clutton[8] relates that in the case of a boy aged 13, with subclavicular dislocation and fracture of the surgical neck of the humerus, reduction was accomplished by incision and direct pressure, after which an ivory peg was driven through both fragments. Recovery ensued, with perfect movements of the joint.

A specimen was shown by Little[9] to the Royal Academy of Medicine in Ireland, in which the greater tuberosity of the humerus was detached, the head of the bone being luxated.

In a case reported by Fenwick[10] a woman aged 41 was struck by a falling timber, and had a fracture of the surgical neck of the humerus, with a wound of the brachial artery; the vessel was exposed and tied above and below, with success, the radial pulse returning in less than forty-eight hours.

A less fortunate result is recorded by Angerer.[11] A woman, aged 32, fell down-stairs, landing on her face, with her left arm adducted and flexed across her chest. Sensation and motion were at once lost, and there was great pain in the shoulder. Gangrene of the limb ensued; disarticulation at the shoulder was performed, and it was found that there was a V-shaped fracture of the surgical neck of the humerus, the radial (musculo-spiral) nerve being torn off, and the other nerves and the vessels strongly compressed by the shaft-end driven up beneath the pectoral muscle.

Powell[12] saw in a child four days old a fracture at the middle of the arm, due to rough handling on the part of a nurse.

Stamforth[13] is reported to have shown to the Sheffield Medico-Chirurgical Society a girl 21 years of age, in whom atrophy of the deltoid, supra-spinatus, infra-spinatus, biceps and brachialis anticus, was ascribed to "a green-stick fracture of the humerus over nineteen years previously."

[1] Archiv für klinische Chirurgie, 1882.
[2] Manual for the Practice of Surgery, 4th ed., 1885, p. 877.
[3] British Medical Journal, Oct. 10, 1885.
[4] La Semaine Médicale, 11 Avril, 1888.
[5] Med. and Surg. Reporter, Nov. 22, 1890.
[6] Lancet, March 29, 1890.
[7] La Semaine Médicale, 24 Sept., 1892.
[8] Lancet, Nov. 17, 1894.
[9] British Medical Journal, April 24, 1886.
[10] Ibid., Sept. 29, 1883.
[11] Archiv für klinische Chirurgie, Berlin, 1889.
[12] Medical Bulletin, Jan., 1884.
[13] Lancet, May 25, 1889.

Cases of non-union of the shaft, treated by wiring, have been put upon record by Wright,[1] by Keeling,[2] by Sibthorpe,[3] and by Symonds.[4]

I have myself met with two cases in which the ends of the fragments, instead of being dense and hard, were so softened that they could not hold the wires, and the patients were obliged to be content with such advantage as they could gain from prothetic appliances.

Cases of paralysis of the parts supplied by the musculo-spiral nerve, from angular deformity or excess of callus after fracture of the shaft of the humerus, have been reported by Puzey,[5] Nicolson,[6] and Murray.[7] The last-named author quotes Bruns as having collected 77 instances of the kind.

Lunn[8] records the case of a woman aged 38, who had a compound comminuted fracture of the right humerus, and six months after union was complete had pain which was relieved by the removal of a spicula of bone pressing up under the fibres of the musculo-spiral nerve; at another operation a mass of callus was gouged away from beneath the median nerve, after which recovery was complete.

In a case recorded by Wheeler,[9] a boy aged 12 sustained a transverse fracture just above the condyles, and the pressure of the end of the shaft of the bone against the brachial artery caused the death of the limb.

Puzey[10] saw a man who a year previously had had his upper extremity crushed in some machinery; he had oblique fracture of the upper third of the humerus, ununited by reason of fascia caught between the fragments; a united fracture at the middle of the shaft; another, ununited, at the junction of the middle and lower thirds; incomplete ankylosis of the elbow; comminuted fracture of both bones just below the joint, ununited; fracture of lower third of the ulna, the upper fragment united to the radius. Various means having been vainly employed to effect union, and suppuration having occurred in the wrist-joint, amputation at the shoulder was performed, and the man recovered.

An unusual case has been reported by Stimson,[11] in which a man about 50 years old had his elbow crushed under a heavy stone, and had the lower end of the humerus broken into three fragments, the condyle and trochlea forming one, the epicondyle a second, and the epitrochlea a third.

Of detachment of the lower epiphysis of the humerus, Tubby[12] cites two specimens and five cases. In one of the cases amputation was necessary, and in two temporary occlusion of the arterial current was noted.

Clark[13] mentions having seen a separation of this epiphysis in a newborn child.

In my former article, allusion was made to the recommendation by

[1] Lancet, Jan. 5, 1884.
[2] British Medical Journal, Jan. 17, 1885.
[3] Ibid., March 10, 1888.
[4] Lancet, Dec. 2, 1882.
[5] Liverpool Medico-Chirurgical Journal, July, 1889.
[6] Gaillard's Medical Journal, Jan., 1890.
[7] New York Medical Journal, June 25, 1892.
[8] Transactions of the Clinical Society of London, vol. xxv., 1892.
[9] Trans. of Royal Academy of Medicine in Ireland, 1889.
[10] British Medical Journal, Jan. 10, 1885.
[11] New York Medical Journal, June 30, 1888.
[12] Loc. cit.
[13] Glasgow Medical Journal, Oct., 1886.

some surgeons that fractures of the humerus close to the elbow should be treated in the straight rather than in the flexed position. This idea has lately been advocated, especially in the case of children and young persons, by Berthomier,[1] by Lauenstein,[2] and by Nunn.[3] Roberts, in a paper read at the meeting of the American Surgical Association in 1892,[4] expressed himself in favor of the straight position, and found fifteen other surgeons who agreed with him by letter in answer to written queries; but sixty-five preferred flexion, and seven "used both." There can be no question that the angle on which the "carrying function" depends can be maintained more conveniently and with more certainty with the elbow in extension; but this is not the only object to be sought. When ankylosis does occur, a straight arm is absolutely useless for anything else; I had in December last to excise an elbow to remedy just such a result, in a boy about 14 years old, and Dr. Ashhurst informs me that he has twice had the same experience lately. Much depends upon the condition of the soft parts; if they are extensively torn, ankylosis in the flexed position, and with the forearm in semipronation, may offer the best, and indeed the only, chance for a useful limb. If on the other hand the muscles and ligamentous structures seem to be intact, or nearly so, and if there is no evidence of inflammatory action within the joint, threatening adhesions, there is no doubt that a good result may be obtained with the elbow either straight or at a very obtuse angle. My own experience has led me to trust in extreme care, early and cautious passive motion, and a very guarded prognosis.

Fractures of the Elbow.

Cheyne[5] has recorded an interesting case in which a boy, aged 13, fell a distance of about ten feet, striking on his elbow; the posterior part of the condyle was chipped off, and the coronoid process was broken into several pieces; these fragments were removed, and the olecranon, which was fractured, was wired, on the fourth day. Four months afterward the wires were removed, as they annoyed him; the movements of the joint were good, and steadily improving.

Fractures of the Bones of the Forearm.

Tubby, in the paper before referred to, cites two instances of separation of the epiphysis of the olecranon; one in a child 2 years old, who was run over by a cart, and died of pyæmia; the other in a boy of 14, from a fall on the elbow, suppurative arthritis ensuing and demanding excision. Very possibly a case reported by Eames,[6] that of a child 4 years of age, may have been of the same nature.

A case in which fracture of the olecranon was the result of slight muscular action, in a miner who "put out his hand to stop a coal-tub, and felt something give way," has been recorded by Symes.[7]

Laver,[8] in a case of two months' standing, the fragments being two

[1] Revue de Chirurgie, Avril, 1888.
[2] Deutsche med. Zeitung, 19 Apr., 1888.
[3] Trans. of the Clinical Society of London, vol. xxv., 1892.
[4] Transactions, p. 15.
[5] British Med. Journal, March 7, 1891.
[6] Ibid., July 16, 1887.
[7] Ibid., April 28, 1888.
[8] Lancet, Nov. 18, 1882.

fingers' breadths apart, scraped, drilled, and wired them together; the patient was discharged after four months, "with perfect union and full power."

An instance is reported by Wright[1] in which a boy of 17 had a fracture of the olecranon, and suffered from atrophy, loss of power, and neuralgia in the muscles and region supplied by the ulnar nerve. A splinter was found detached and pressing on the nerve; it was removed, the fragments were freshened and wired together, with a good result.

Excision of the elbow-joint was performed by Lloyd[2] in a man aged 27, who had a fracture of the ulna from the upper end of the olecranon downward and forward to the middle of the sigmoid notch, the fragment being driven forward so as to narrow the cavity and prevent the reduction of the humerus into it. The result is not stated.

Fractures of the coronoid process led to excision of the joint in a case recorded by Lediard,[3] and in three by Annandale.[4] In all these the elbow was luxated backward. Holmes, discussing Lediard's case, said that there was in the museum of St. George's Hospital a specimen of fracture of both the coronoid processes in the same subject. In two of Annandale's cases the detached portion was found adhering to "the *posterior* aspect of the inner condyle" (epitrochlea?).

Two cases are mentioned by Tubby in which there was separation of the upper epiphysis of the radius.

Several cases of fracture of the head or neck of the radius have been put upon record. Annandale[6] has reported three. In one, a man aged 48 struck his wrist against his knee; three months later, his elbow being disabled, an incision was made, and the loose fragment was removed. In another, a young woman fell and struck her elbow; nine months afterward, the joint being firmly fixed in the straight position, the head of the radius, broken off and split into two pieces, was excised, with a good result. The third case was similar to the last, the specimen only being mentioned.

Stimson[6] gives the case of a man in whom this injury was complicated with a fracture of the coronoid process; in the third week arthrotomy was performed, and the head and neck of the radius were removed; a good recovery ensued, with flexion to 45°, pronation complete, but supination limited. Another like case, in a lady aged 26, is recorded by Cheyne.[7] Delorme[8] saw a case diagnosed as "partial longitudinal fracture of the head of the radius," in which perfect recovery ensued.

In a case reported by Felkin[9] the patient, a woman aged 21, fell with her whole weight on her elbow, and sustained a fracture of the radius an inch below its head; the ulnar nerve was also dislocated forward, and had to be replaced by operation.

Stimson[10] mentions a curious case in which a boy of 13 had the outer half of the head of the radius detached by a blow from the runner of a sled. The diagnosis was verified upon the excision of the joint, made necessary by suppurative arthritis. Another instance, in which the

[1] New York Med. Journal, May 7, 1887.
[2] British Med. Journal, March 17, 1888.
[3] Lancet, May 3, 1884.
[4] Edinburgh Med. Journal, Feb., 1885.
[5] Ibid.
[6] New York Med. Journal, Nov. 24, 1888.
[7] British Med. Journal, March 7, 1891.
[8] Gaz. des Hôpitaux, 17 Mars, 1891.
[9] Edinburgh Med. Journal, July, 1887.
[10] Treatise on Fractures, p. 433.

head of the bone was broken into three portions by great violence, in an adult, is recorded by Adams.[1]

Fracture just below the insertion of the biceps, in a man aged 22, who fell on a floor, has been noted by Bird.[2] The forearm was kept in supination, and it is stated that recovery was perfect.

Fracture of both bones of the forearm is said by Humphry[3] to have been seen by him as the result of convulsions in whooping-cough, in a child.

Several instances of serious consequences from these injuries have been reported. In one, by Puzey,[4] a boy aged 15 had a compound fracture, the union of which was delayed, and there was progressive paralysis of the ulnar nerve, with wasting, and "clawing" of the fingers; the nerve was freed by operation, and function was gradually but completely restored. In another, by Lane,[5] a simple fracture of both bones gave rise on the twentieth day to extensive thrombosis, with much œdema, pain, and tenderness; another attack occurred in three weeks, and still another two weeks later involved the innominate and internal jugular veins, threatening life; this gradually subsided, but came on again in twenty-five days, and once more seven weeks after that. Union failed in the radius. Molitor[6] quotes from Jungst a case in which a simple fracture of both bones of the forearm by machinery caused occlusion of the brachial artery, and gangrene of the limb.

The resulting deformity is sometimes troublesome, as in a case recorded by Gayraud,[7] in which a girl 8 months old had both forearms broken; when seen by him twenty months later, on the right side union had taken place with the fragments at a right angle "like a second elbow;" on the left side the angle was less marked. Straightening was successfully accomplished.

Robson[8] saw a boy 6 years old, who four years before had been run over by a cart, and had probably sustained a fracture of both bones; he had had no treatment, but the only trace of the injury was a projection of the radius upward and inward just below its head; supination was impaired.

Dr. H. R. Wharton has mentioned to me that in 1888 he saw a boy aged 12, who by a fall from a horse had sustained "a fracture of the lower end of the radius, with great deformity, the hand being markedly drawn inward, and the ulna being decidedly curved in the same direction, the point of greatest curving being about two inches above the styloid process. In making pressure to reduce the deformity, the ulna gave way with a snap at the point above mentioned." Reduction was then easy, and the boy recovered "with a very perfect arm."

Three years ago I had at the Pennsylvania Hospital a boy aged 8 years, who some months previously had had both bones of his right forearm broken about an inch above the wrist. Necrosis of the fragments followed, and I removed the end of the ulnar diaphysis and part of the radial, leaving the epiphyses in place.

[1] Trans. of the Pathological Society of London, 1871.
[2] Australian Med. Journal, May 15, 1889.
[3] British Med. Journal, Nov. 15, 1884.
[4] Ibid., May 16, 1885.
[5] Medical Times and Gazette, May 3, 1884.
[6] Beiträge zur klin. Chirurgie, 1889.
[7] Gaz. Hebdom. des Sciences Méd. de Montpellier, 3 Sept., 1887.
[8] Lancet, March 21, 1885.

Of fracture near the lower end of the radius, a number of cases have been reported.[1] In one, seen by Hinshelwood,[2] both wrists were broken by a fall down-stairs; in the right there was the ordinary deformity, but in the left it was reversed, a hollow existing on the dorsum, and a corresponding prominence in front.

A point which seems to have hitherto been unnoticed is the effect of obliquity of the line of fracture upon the deformity. This I have several times seen; an illustration of it has been given by Lockwood.[3]

Curtis[4] has reported the case of a man aged 41, who sustained a Colles's fracture, which did well, and he returned to work; two days afterward he made a sudden grasp with the injured hand, and the bone gave way again, apparently in exactly the former line.

A fatal case of tetanus after an injury of this kind, in a boy aged 15, has been recorded by Waitz;[5] also another case, in which the symptoms subsided upon resection of the bulky callus, and freeing of the radial nerve, in a boy of the same age, by Brunner.[6]

These fractures are generally said to be infrequent in early life; but it has occurred to me to have at the Pennsylvania Hospital, within a period of forty-eight hours, four cases in patients between 5 and 12 years of age. All these were from simple ordinary falls on the hand; there was no ice on the ground, nor any other circumstance to account for the coincidence.

I lately had a very striking instance of separation of the lower epiphysis of the radius, in a boy 10 years old, who had fallen on the ground; under ether the fragment went into place with a click plainly heard by the bystanders.

In a case recorded by Wickes,[7] a boy 12 years old fell a distance of twenty-five feet, and had a compound separation of the lower epiphysis of the radius, the shaft protruding; the ulna was broken about 1½ inches higher up. On the third day gangrene ensued, necessitating amputation above the elbow; the boy recovered.

Here, as elsewhere, failure in the growth of the bone has sometimes been observed as the result of these epiphyseal disjunctions. The subject has been recently discussed by Stehr,[8] with records of three new cases, and reference to those previously reported by Hutchinson, Goyrand, Poncet, and others.

As to the treatment of fractures of the lower end of the radius, there has been nothing wholly new proposed. I have myself found entire satisfaction in the use of a small splint carefully fitted so as to fill up the normal hollow of the anterior or palmar aspect of the radius, in order to maintain reduction after this has once been thoroughly effected, this splint being kept in exact place by a broad band of rubber plaster firmly applied.

[1] St. Bartholomew's Hospital Reports, 1887; Trans. of Pathological Society of London, vol. xxxviii.
[2] British Med. Journal, Nov. 3, 1888.
[3] Trans. of Pathological Society of London, 1884.
[4] New York Medical Journal, Feb. 21, 1891.
[5] Report of Esmarch's Clinic, Archiv für klin. Chirurgie, 1877.
[6] London Medical Recorder, July 15, 1886.
[7] Med. Times and Gazette, Dec. 22, 1883.
[8] Beiträge zur klin. Chirurgie, v., 1889.

Fractures of the Femur.

Cases of separation of the upper epiphysis of this bone have been reported by Noble Smith,[1] by Robson,[2] by Maylard,[3] and by Davies-Colley.[4]

I had in my wards at the Pennsylvania Hospital, in 1889, a case which I believe to have been of this character. It was that of a boy 14 years old, who had been knocked down in a scuffle, striking on his hip; he had some shortening and eversion of the limb, with pain, and a muffled crepitus in the neck of the bone. He was treated with extension and sand-bags, and recovered perfectly in nine weeks, with a limb apparently of normal length.

Whitman[5] thinks that fractures of the cervix femoris are not uncommon in children, and that when the diagnosis is doubtful the presumption is in favor of this form of injury rather than of epiphyseal separation. He gives five instances, in children from 2½ to 8 years old, in which the neck of the bone was thought to be broken, all resulting in cures. In either case the indications are to make extension and to prevent rotation, so that the question is one of no great practical importance.

With regard to fractures of the neck of the femur, the views presented in my former article are those which I still entertain. Senn's proposition,[6] that the distinction between intra-articular and extra-articular fractures should be abandoned, was long ago made by Bigelow,[7] and may be accepted without question, since practically the diagnosis can rarely be made during life. Some cases there undoubtedly are, in which a degenerated bone breaks across at its narrow part, near the head; and in other cases the age and the general condition of the patient preclude the hope of repair. I have now under my care at St. Joseph's Hospital a woman 92 years old, who a week ago sustained a fracture of the femoral neck, who has already, in spite of every care, a large bedsore. To apply any apparatus in her case would have been simply cruelty. But in the vast majority of instances the fracture is oblique, the line running down toward the lesser trochanter; and in very many there is more or less impaction. Such was clearly the character of a case reported and figured by Raven.[8] The practical deduction is, that if the necessary restraint can be borne, an effort should always be made to obtain union. For this purpose the ordinary and well-known dressings, applied with due care, are sufficient. Senn proposes the encasement of the patient, from the level of the cartilages of the eighth ribs down to the knees, in a plaster apparatus; into this on the injured side is let in a bracketed metal splint, the bracket perforated for a screw carrying a flat pad, which shall press against the trochanter, and thus hold the outer fragment closely in contact with the inner. Eight cases are adduced in which good results attended upon the employment of this apparatus; results, however, certainly not any better than those

[1] Lancet, March 20, 1886.
[2] Ibid., Aug. 21, 1886.
[3] British Med. Journal, April 2, 1892.
[4] Trans. of Clinical Society of London, vol. xxv., 1892.
[5] Medical Record, Feb. 25, 1893.
[6] Journal of the Am. Med. Association, Aug. 3, 1889.
[7] The Mechanism of Dislocation and Fracture of the Hip, p. 126. (Quoted in my former article.)
[8] Lancet, Aug. 6, 1887.

which I am myself accustomed to obtain, or than those which I have seen in the practice of others. Nor does this method seem to shorten appreciably the duration of treatment.

Blaker [1] claims to have had a case of recovery in one month, from an impacted fracture of the femoral neck, in a woman aged 57, treated merely with extension.

Cheyne [2] gives the case of a woman aged 52, in whom the fragments were pegged together with ivory, there being no impaction, but a shortening of 1½ inches; the dressings were finally removed on the 61st day, and on the 131st she was dismissed; a month after she was again seen, and the result was reported to be "fairly good."

In a case of non-union of the femoral neck in a robust man, aged 36, injured nineteen months previously, Loreta [3] is said to have obtained success by opening the joint from behind, dividing the fibrous tissue between the fragments, scraping the ends of the latter, and introducing eight or ten metallic wires between them for five days; union took place by first intention, in less than a month there was no pain, and on the fifty-fifth day the patient walked with only the aid of an attendant's hand. The use of the wires here would seem to have been merely as a sort of seton, and there must have been great risk of setting up an arthritis.

Allis has discussed [4] the causes of difficulty in the treatment of fractures in the upper third of the femoral shaft, which he thinks have hitherto been misapprehended. He argues that the shortening is due to angular displacement, only aggravated by extension; and proposes to resort to an operation, laying bare the fragments and securing their apposition by means of metal screws, in all such cases. Bold as this suggestion may seem, it is supported by very strong arguments, and certainly merits full consideration.

Fractures of the shaft of the femur by muscular action have been reported by Burr [5] (two cases, both in paretics), by Ewing, [6] by Lydston, [7] and by Beck [8] (in a boy only 6½ years old, who was trying to lift a playmate on his back). I have myself recently seen a similar case in a man aged 30, apparently quite healthy, whose femur gave way as he slipped on the ice and tried to avoid a fall.

The subject of the treatment of fractures of the shaft of the femur, and of the results to be expected, was discussed by Dr. Stephen Smith in an excellent paper presented to the American Surgical Association in 1890. [9] A committee was appointed to consider the matter, and reported [10] at length, with the following conclusions: A satisfactory result has been obtained when—

"1. Firm bony union exists.

"2. The long axis of the lower fragment is either directly continuous with that of the upper fragment or is on nearly parallel lines, thus preventing angular deformity.

"3. The anterior surface of the lower fragment maintains nearly its normal relation to the plane of the upper fragment, thus preventing undue deviation of the foot from its normal position.

[1] British Med. Journal, Nov. 28, 1885.
[2] Ibid., March 7, 1891.
[3] Ibid., Aug. 25, 1888.
[4] Medical News, Nov. 21, 1891.
[5] Medical Standard, December, 1889.
[6] British Med. Journal, March 21, 1889.
[7] Physician and Surgeon, Oct., 1892.
[8] Jahrbuch für Kinderheilkunde, 1886.
[9] Transactions, vol. viii., p. 39.
[10] Ibid., vol. ix., p. 81.

"4. The length of the limb is either exactly equal to its fellow, or the amount of shortening falls within the limits found to exist in 90 per cent. of healthy limbs, viz., from one-eighth to one inch.

"5. Lameness, if present, is not due to more than one inch of shortening.

"6. The conditions attending the treatment prevent other results than those obtained."

Dr. Smith's paper, with the discussion upon it, and the full report of the committee, are well worthy of study.

Thiriar is said [1] to have devised a combination of the starched bandage with extension by weight and pulley. He first applies one section of the bandage, with the extension, to the leg; a second section is then put on the thigh, overlapping the former in telescope-fashion. The thigh-part may be slit up so as to expose the limb, and when closed may be kept so by means of straps and buckles.

Mention may perhaps be appropriately made here of a report by R. W. Parker [2] of five cases of intenticnal fracture of the femur for the correction of deformities.

Kennedy [3] reports the case of a man aged 38, who was carried down thirty feet in the wreck of a scaffolding, sustaining among other injuries a comminuted fracture of the right femur at the upper part of its middle third. About two weeks afterward, the shortening amounting to three inches, an incision was made exposing the bone, when the lower fragment was found at the outer side of the upper, both, with some splinters, being embedded in a mass of callus. Resection was performed, and the ends wired together. Ten weeks later union was firm, and the patient could bear almost his entire weight upon the limb, which, however, was shortened two and three-quarter inches.

An interesting case is recorded by Collings [4] in which a sailor aged 30 had had, fifteen months previously, a fracture of the shaft, badly united, with a shortening of six inches. By resection and subsequent extension the deformity was corrected, and union was obtained with only two inches of loss of length, and good use of the limb. Other instances have been reported by Heath [5] and Lorenz.[6] In the latter case the fracture, in a boy aged 10 years, was situated in the upper third of the shaft, and had occurred five and one-half years previously. Union had taken place with an angle outward. By chiselling the fragments apart, and free division of muscles and tendons, a very good result was secured.

Cases of non-union successfully treated by wiring have been recorded by Tobin,[7] Robson,[8] Owen,[9] and Leeming.[10] In two other cases, one reported by Jacobs [11] and the other by Treacy,[12] the lesion was seated in the lower third of the bone, and in each the distal fragment was tilted down into the popliteal space by the gastrocnemius muscle. In each case, suturing of the ends with silver wire resulted in firm union, but with two inches of shortening of the limb.

Marks [13] has recorded the case of a girl aged 14, who at the age of

[1] Editorial in the Lancet, July 2, 1887.
[2] Med. Times and Gazette, Dec 29, 1883
[3] Med. Record, Dec. 19, 1891.
[4] Lancet, April 5, 1890.
[5] Ibid., March 15, 1887.
[6] Wiener med. Wochenschrift, 3 und 10 Jan., 1891.
[7] Lancet, July 5, 1884.
[8] British Med. Journal, Dec. 6, 1884.
[9] Ibid., Nov. 21, 1885.
[10] Lancet, Jan. 29, 1887.
[11] Medical Record, Jan. 14, 1888.
[12] New York Med. Journal, Nov. 5, 1892.
[13] Journal of American Medical Association, Nov. 6, 1886.

two and one-half years had a fracture of the femur at two points; it did not unite for six months, when a fragment was removed from the lower portion; the muscles shrank, and the knee became stiff. At thirteen years and seven months, a new fracture occurred at the junction of the middle and lower thirds; plaster-of-Paris was applied for three months, and then the fractured ends were rubbed upon one another; the plaster was reapplied, and she got up upon crutches; union was finally obtained with 1¼ inch shortening.

Rehn [1] reports a case of chipping off of the external condyle in a man aged 29, who was crushed under a falling wall; sixteen years afterward he had a slight injury of the foot, followed by suppuration of the knee-joint, within which the fragment was found. Dr. Mynter, of Buffalo, N. Y., has shown me two specimens of the same kind, the separated fragments having become smoothed and nodulated, but whether by abrasion or by deposit of new material could not be certainly determined. Another case has been reported by Wickes.[2]

In a case reported by Wills,[3] a boy aged 12 sustained, by a railroad accident, a fracture of both femora, a compound fracture of the nasal bones with concussion of the brain, and severe general contusions; yet he made a good recovery.

Barclay [4] saw a man aged 22, crushed by a fall of earth, who had a fracture of the femur, and laceration of the scrotum with protrusion of the testis, followed by tetanus, but who recovered, and was discharged cured on the seventy-fourth day.

Bull [5] gives an account of a man aged 56, who had a comminuted fracture of the lower end of the femur. "A large slice of bone had been broken off the lower end of the femur from the anterior surface, the condyles being split laterally and longitudinally; the fracture had become united by callus." It is further stated, however, that "suppuration in the knee-joint ensued on the hemorrhage into the joint due to the injury," and amputation became necessary.

In another case, reported by Annandale,[6] a man aged 50 had a simple fracture about two inches above the condyles; on the third day, the limb having become gangrenous, amputation was performed, and it was found that the popliteal artery and vein had been ruptured, and both crucial ligaments torn through. A somewhat similar case has been recorded by Mudd,[7] and another by Péraire,[8] in which, however, the amputation was postponed until the forty-eighth day.

Kennedy [9] records the case of a boy aged 13, who had his left leg caught in the wheel of a wagon, and who sustained a fracture of the femur close to the knee-joint. The lower fragment was displaced forward, its fractured surface resting upon the anterior surface of the upper fragment. Reduction was effected, but could not be maintained; the lower end of the upper fragment projected in the popliteal space, and became necrosed. Four weeks after the accident, the parts were exposed by an incision along the outer border of the biceps tendon; the necrosed part of the bone was removed, and the other fractured surface

[1] Verhandl. der Deutschen Gesellschaft für Chirurgie, 1889.
[2] Med. Times and Gazette, Dec. 22, 1883
[3] British Med. Journal, June 21, 1884.
[4] Ibid.
[5] Lancet, Dec. 24, 1887.
[6] Ibid., July 2, 1887.
[7] Journal of the Am. Med. Association, March 31, 1888.
[8] Revue de Chirurgie, Février, 1889.
[9] Loc. cit.

freshened. Ultimately the boy recovered with a useful limb, the knee-joint being supple, and the shortening amounting to only an inch.

Separation of the Lower Epiphysis of the Femur.—On this subject a very excellent paper has been published by Delens,[1] with an account of a case seen by him, and citations at more or less length of 27 others from various sources. In 1889, a case occurred under my own care at St. Joseph's Hospital; and in preparing a report[2] of this I collected over 30 additional instances, making in all nearly 70. In my own case, and in 26 others, the injury was due to entanglement of the leg in a moving wheel. In 3 of these, and in 6 cases due to other causes, the subjects were girls. In 45 of the cases the age of the patient was given, showing an average of 7 years.

In 14 cases reduction was effected; 2 of the children are said to have had good motion; 1 had a stiff knee; of 7 it is merely said that they did well, or had useful limbs, and in 2 the only statement is that consolidation occurred. One death occurred, from "purulent infection."

Resection of the end of the shaft was performed in 6, successfully in 4; 1 case was doubtful at the time of the report, and in 1 the result is not stated.

Amputations were resorted to in 29 cases, 13 primary, 9 secondary, 5 very late, 2 not stated. In 2 resection of the knee was followed by amputation.[3]

[1] Archives Générales de Médecine, Mars et Avril, 1884.

[2] Annals of Gynæcology and Pædiatrics, Nov., 1890.

[3] For the convenience of those who may wish to examine them, I append a list of references, embracing all the writings on the subject which have been within my reach. Delens, in the paper before referred to, mentions two or three theses to which I have not had access.

Fontenelle, Archives Générales, etc., Oct., 1825; C. Bell, Observations on Injuries of the Spine and Thigh-bone. London, 1826, p. 42; R. Alcock, Medico-Chirurgical Transactions, 1840, p. 311; Liston, Elements of Surgery. London, 1840; C. Hawkins, Lancet, May 7, 1842; White, Ibid.; James, Ibid.; R. Adams, Todd's Cyclopædia of Anatomy and Physiology, art. "Knee-joint," vol. iii., p. 69, London, 1839–47; Quain, Lancet, March 11, 1848; Jarjavay, Traité d'Anatomie Chirurgicale, 1852, tome i., p. 70; Trélat, Archives Générales, etc., Juillet, 1854; also, Le Progrès Médical, 21 Août, 1875; Canton, Lancet, Aug. 28, 1858; also, Trans. of Pathological Society of London, 1860; Hilton, Med. Times and Gazette, Feb. 12, 1859; Holmes, Trans. of Pathological Society of London, 1862 (two cases), also, Surgical Treatment of Children's Diseases, London, 1868; Hutchinson, Trans. of Pathological Society of London, 1862, also, Ibid., 1864; Little, New York Journal of Medicine, Nov., 1865, also, Illustrated Medicine and Surgery, New York, 1862; Voss, New York Journal of Medicine, Nov., 1865; Buck, Ibid.; Volkmann, Virchow's Jahresbericht, 1866, Bd. ii., S. 337; Gay, Lancet, Oct. 12, 1867; Rougon (reported by Dolbeau), Bull. de la Société de Chirurgie, 1867, p. 120; Hey, British Medical Journal, Dec. 4, 1869; Wheelhouse, Ibid.; Maunder, Lancet, Feb. 5, 1870; Leisrink, Archiv für klin. Chirurgie, 1872, S. 436; Chauvel (quoted by Spillmann), Dict. Encyclopédique, art. "Cuisse," 1872; Callender, St. Bartholomew's Hospital Reports, 1873; Tapret et Chenet, Bull. de la Société Anatomique, 8 Janv., 1875; St. Thomas's Hospital Reports (statistical table), 1875; Marcano, Bull. de la Société Anatomique, 3e série, tome x., 1875, p. 228; Richet, L'Union Médicale, 16 Mars, 1876; Sheppard, St. Thomas's Hospital Reports, 1877; Simon, Ibid. (quoted by Sheppard); Smallwood, Hamilton on Fractures and Dislocations, 1877; Reeve, Cincinnati Lancet and Clinic, Nov. 16, 1878; Allis, Trans. of Pathological Society of Philadelphia, 1878, p. 7; Turgis, Bull. de la Société de Chirurgie, 1878, p. 787; Holthouse, Holmes's System of Surgery, vol. i., 1880; Menard, Revue de Chirurgie, 1881, p. 738; Davison, Gross's System of Surgery, 1882; Puzey, Brit. Med. Journal, Oct. 21, 1882; Bruns, Archiv für klinische Chirurgie, 1882, S. 254; Delore, Ibid. (quoted in Bruns's tables); McBurney (quoted by Little) Illustrated Medicine and Surgery, 1882; Halderman, Med. Record (New York), June 3, 1892; Atkinson, Brit. Med. Journal, July 14, 1883; Robson, Liverpool Medico-Chirurgical Journal, July, 1883; Black, Ibid. (quoted by Robson); Rathbun, St. Louis Courier of Medicine, March, 1884; Verneuil, Mémoires de Chirurgie, tome iii., 1884, p. 400; Broca, Bull. de la Soc. Anatomique, 4e série, tome ix., 1884, p. 407; Winslow, Maryland Med. Journal, June 21, 1884; Bryant (reported by Rhys), Brit. Med. Journal, May 31, 1884; Bryant (reported by Walker), Ibid.; Wheelhouse, Ibid., May 24, 1884; McGill, Ibid.; Delens, Archives Générales, etc., Mars et Avril, 1884; Broca, Bull. de la Société Anatomique,

Mansell Moullin[1] has reported the case of a boy aged 15, who had a vertical fracture through his epiphysis, which united by bone; a slight obliquity of one fragment caused pressure upon the popliteal artery, which gave way, and suppurative arthritis of the knee led to amputation a year afterward. On maceration, the epiphysis separated at the line of junction with the shaft.

Fractures of the Patella.

During the last ten years the additions to the literature of this subject have been very voluminous, chiefly with reference to methods of treatment and their results.

Two cases are reported in which the patella has been excised; in one, by Dodd,[2] for disease, and in the other, by Altham,[3] for compound comminuted fracture. Both patients recovered with useful limbs; so that it would seem that the bone is not indispensable.

A Russian surgeon, Geier, is said[4] to have met with an instance of nearly longitudinal fracture of this bone by muscular action, in a man who made a great effort to lift a heavy sack. There is no mention of the treatment pursued, nor of the result.

A unique case has been recorded by Parke.[5] A miner, aged 22, had his leg caught between two cars, so that the patella was split vertically from side to side, the anterior half remaining attached to the ligamentum patellæ, while the posterior was drawn upward by the quadriceps; so that there seemed to be a bone of double the normal length, and half the normal thickness. Dressings were applied to correct the displacement, and at the time of the report a good result seemed probable.

In a case recorded by Clarke[6] a man, aged 28, struck his knee against a step; the internal semilunar cartilage was found to be loosened, and in operating for its suture, it was noted that a piece of the cartilage on the under surface of the patella had been knocked off; it floated up into view, and was found to fit accurately to the abraded surface.

Alderson[7] describes a specimen taken from a man who died of apoplexy, having broken his knee-cap twenty-three years before; he had been treated with pads and adhesive strips, and a gum-and-chalk bandage; the bond of union between the fragments was chiefly ligamentous, but in its centre there was a complete bridge of bone. The extent of separation of the fragments is not stated.

One of the adverse conditions met with is illustrated in a case reported by Gem.[8] In a man aged 60, the fragments could not be properly brought together; on his death, three months after the accident, the knee-joint was found to contain three ounces of clotted blood, which pushed up the fragments and kept them wholly apart.

4e série, tome x., 1885, p. 228; Reverdin, Revue de la Suisse Romaine, 15 Mai, 1886; Hutchinson, Illustrations of Clinical Surgery, vol. ii., 1888; John H. Packard, Annals of Gynæcology and Pædiatrics, Nov., 1890; John H. Owings, Medical Record, Jan. 31, 1891; McDiarmid, Northern Lancet and Pharmacist, April, 1892.

[1] Lancet, Nov. 18, 1887.
[2] British Med. Journal, March 22, 1884.
[3] Ibid., April 9, 1887.
[4] Edinburgh Med. Journal, Feb., 1890.
[5] New York Med. Journal, March 18, 1893.
[6] Trans. of the Pathological Society of London, 1892.
[7] British Med. Journal, April 23, 1887.
[8] Ibid., Sept. 1, 1883.

Lunn records the case of a man aged 44, who in 1869 had sustained a fracture of the left patella, which united well, but gave way again six months afterward; no union could be obtained, and the fragments were four and a half inches apart; the knee became the seat of gnawing pains, and the limb would give way in spite of careful splinting. The joint was therefore excised in 1885, and the man made an uninterrupted recovery.

Upon the subject of *treatment*, I shall first cite the recorded results of experience with various methods, and then the opinions derived therefrom.

Thomas[2] claims excellent results from his "indirect" method of fixation of the knee, by means of a wire frame extending from the pelvis to the sole of the foot, with bands in front of the leg and thigh, and behind the ham. He attempts no control of the fragments, thinking that "neither position nor nicety of adaptation during treatment is in any way essential to a good result."

Another plan, brought forward as new by Masing[3] and said to have been successfully used by him in four cases, is essentially the same as the one described in my former article as employed at the Middlesex Hospital in London.

Heath[4] recommends the immediate application of plaster-of-Paris bandages, and is in favor of aspiration of the knee-joint.

Malgaigne's hooks have been advocated by Treves.[5] He prefers straps of webbing to keep the limb fixed upon the splint, and advises that the knee should be exposed to the air, believing that the confinement in a close and heated atmosphere may account for the slow healing of injuries of the lower extremity.

Myles[6] passes steel pins transversely through the fragments, and then draws them together by figure-of-eight turns of thread or wire about their free ends. Robson[7] draws the skin well up from the upper fragment, and down from the lower, and then passes steel pins across through the quadriceps tendon and the ligament of the patella; the pins are then clipped off about half an inch from the skin, and the knee enveloped in antiseptic gauze. The pins are left in place about three weeks; plaster-of-Paris is then applied, and afterward a Thomas's splint. Horne[8] believed that he obtained bony union in a case thus treated. In discussing Robson's method, R. W. Parker raises the question whether it is worth while to try to get bony union, citing another instance in a woman who broke both patellæ at different times; the first fracture healed by bone, the second with fibrous union and considerable separation, but with just as good use of the limb. Haward mentioned a case in which a patient with fibrous union was able to ride on a bicycle.

McLaren[9] reported the case of a man who fractured his right patella in 1864, and his left in 1867; in each the fragments were connected by a fibrous band, three inches in length on the right side, one inch on the left, but both limbs were capable of free use. The curious statement

[1] British Med. Journal, May 8, 1886.
[2] Provincial Med. Journal, Aug. 1, 1889. See also Med. Press and Circular, Oct. 11 and 25, 1882.
[3] St. Petersburg med. Wochenschrift, 10 Juni, 1889.
[4] British Med. Journal, May 17, 1884.
[5] Ibid., July 24, 1886.
[6] Ibid., March 16, 1889.
[7] Ibid., March 30, 1889.
[8] Lancet, Jan. 18, 1890.
[9] Edinburgh Med. Journal, March, 1885.

is made that this man's father, brother, and sister had each sustained fracture of the right patella.

Richelot is quoted[1] as urging the importance of maintaining the tone and nutrition of the quadriceps muscle, rather than of bringing the fragments together. He says that many persons with nearly four inches of separation can walk well, and go up and down stairs.

I have myself, in cases under my care, found advantage in securing control of the quadriceps muscle by means of a sheet of rubber-plaster, closely applied at the lower half of the thigh, and with a crescentic edge exactly adapted to the upper margin of the patella, the fragments being first brought as nearly as possible together. Another long strip of rubber-plaster may be carried along down each side of the leg so as to hold the first in place.

When my former article was written, the idea of exposing and suturing the fractured patella had been suggested, and carried out in a few instances. But soon afterward, in a paper[2] read before the Medical Society of London, Lister made an urgent plea for its general adoption; exhibiting six patients on whom he had successfully employed it. His views were freely discussed, and the propriety of such operations questioned, by Holmes, Heath, Bryant, Morris, Sydney Jones, Gant, and Morrant Baker.

Turner[3] reported a case in which a man, aged 39, had his left patella broken in 1859; early in 1881 he fell, and the already stretched fibrous union yielded so that the separation was over 2½ inches. The fragments were then wired together, but suppuration ensued and the knee became stiff. In connection with this report there is an analysis of 50 cases of wiring of the patella; anchylosis, or at least a stiff knee, resulted in 8, and in 3 the issue was fatal.

Abbe[4] exhibited to the New York Surgical Society the patellæ of a man aged 60, who some years ago had been operated on by wiring, by Dr. Markoe. Suppuration had occurred on both sides; bony union had been obtained, but with anchylosis of both knee-joints.

Hardie[5] reported four cases, in all of which the patients were able in four months to walk well and to bend the knees to 90°. He thought Lister's operation "one of the finest examples of modern high-class surgery," and advocated its adoption as the routine treatment.

Against this view Davidson[6] cites the case of a man aged 40, in whom the suture of a patella fractured four months previously was followed by necrosis, suppuration, bedsores, and death.

Favorable results have been recorded by Page,[7] Ceci,[8] Lammiman,[9] Pickering,[10] Rockwell,[11] and Wight.[12] The last-named surgeon gives four cases, and expresses his confidence that this procedure will become the established practice. He thinks only one suture necessary, and that the best time for applying it is between the tenth and the fifteenth days.

Dennis,[13] from a review of reports from various sources, embracing

[1] London Med. Recorder, July 15, 1885.
[2] British Med. Journal, Nov. 3, 1883.
[3] Ibid., Nov. 17, 1883.
[4] New York Med. Journal, Aug. 10, 1889.
[5] Ibid., Nov. 28, 1885.
[6] Ibid., Dec. 12, 1885.
[7] Lancet, April 12, 1884.
[8] Deutsche Zeitschr. für Chirurgie, 1888, S. 245.
[9] British Med. Journal, Oct. 3, 1885.
[10] Ibid., Feb. 23, 1889.
[11] Brooklyn Med. Journal, June, 1888.
[12] Ibid., Feb., 1888.
[13] New York Med. Journal, April 3 and 10, 1886.

186 cases, argues in favor of operation under certain favorable conditions, and with rigid attention to asepsis.

Phelps [1] advocates it without reserve, citing 42 cases so treated within five years. He would take no account of age, habits, or constitutional state; thinks it better that the suture should enter the joint; but lays stress on closing this cavity and isolating it from the skin wound. He regards four weeks as the limit for the confinement of the patient to bed. In the discussion on the paper, these views were opposed by Abbe, Bryant, Leale, Stimson, and Stephen Smith.

Bogdanik [2] sutured a recent fracture of the patella, and thought that he had obtained bony union. The patient dying of pneumonia eighteen months afterward, the fragments were found to have between them a strip of whitish substance like cartilage, 2 or 3 millimetres in width, but no bone; in the lower fragment, which was broken into several pieces held together by the periosteum, bony union had taken place. In another instance, mentioned by Grandclément,[3] an autopsy showed in a patella "long before" sutured, the union only fibrous, and the sutures far from the place of their application.

Ollier [4] would divide fractures of the patella into three categories: recent or immediate; old cases, in which there are adhesions with atrophy and retraction of the muscles; and intermediate cases, at the sixth or eighth month. In the first set he regards cutting operations as premature; in the others, to be adopted or rejected according to circumstances.

Kirmisson [5] reports three cases. He thinks suturing a grave procedure to be employed in view of the condition apt to be obtained without it, and would restrict it in recent cases to those involving the knee-joint, and in old cases to those in which the approximation of the fragments is either extremely difficult or altogether impossible.

Bruns [6] says that the mere degree of separation is not the criterion of a bad result. Every writer speaks of cases in which "to his astonishment" there is almost unimpaired function in spite of unsatisfactory healing. Such instances, to the number of ten, he cites from Bardeleben and other well-known surgeons.

Beck [7] after an analysis of twenty-eight cases, takes ground decidedly against bloody operations; the local result, he admits, is better, but the risk is very great, notwithstanding the claims made by Lister and others. The results of the older methods, he says, are so good that the exposure and suturing of a recently fractured patella can only be justified when there is at the same time a wound of the soft parts, opening into the joint.

Another method, that of passing a suture of silver wire subcutaneously around both fragments, was proposed, I believe, by von Volkmann.[8] Silk has been substituted by Kocher and others, and many successes have been claimed for the procedure, the details of which will at once suggest themselves.

Other measures have been resorted to in special cases. Sonnenberg [9]

[1] New York Med. Journal, May 31 and June 7, 1890.
[2] Centralblatt für Chirurgie, 12 Feb., 1887.
[3] Lyon Médical, 8 Fév., 1891.
[4] Ibid.
[5] Gaz. des Hôpitaux, 2 Oct., 1888.
[6] Beiträge zur klinischen Chirurgie, Band iii., Heft 2, 1888.
[7] Ibid.
[8] Ashhurst, Principles and Practice of Surgery, 5th edition, 1889, p. 279.
[9] Beilage zum Centralblatt für Chirurgie, 1888, No. 24.

had a patient in whom the ligamentous union of a patella, fractured in 1884, had given way in 1887; the quadriceps was somewhat atrophied. The tubercle of the tibia was chiselled away, and attached higher up; it was still very difficult to approximate the fragments, but finally bony union was obtained, with active extension of the joint, and flexion to 90 degrees.

Fowler,[1] in a boy 17 years old, whose patella had been broken and closely united, but who by a fall had stretched the bond of union to 2½ inches, found it difficult to bring the fragments together; he therefore made an incision 8 inches long over the front of the thigh, made four oblique cuts through the quadriceps muscle, in the shape of the letter W, and by drawing downward opened these out so as to gain enough length in the muscle. The fragments were now freshened and sutured together, with a good ultimate result. The above device is credited to MacEwen of Glasgow.

I believe the reader will obtain from the foregoing pages a just idea of the current of opinion, and of the recorded experience, on the subject of the treatment of fractures of the patella. I would say that, thoroughly convinced of the value of antiseptic or aseptic methods, I feel bound to modify somewhat the views expressed in my former article.

My own personal experience has abundantly satisfied me that by these modern safeguards the risks of the operative surgery of the knee-joint are materially lessened if not wholly set aside. I have repeatedly laid the joint open and washed it out, in cases of gunshot injury, of incised wound, and of compound fracture, with entire success. For this reason I should not hesitate, in dealing with a limb rendered useless by the non-union of a broken patella, to advise the exposure and suturing of the fragments. Nor should I dread the use of the subcutaneous circumpatellar suture, in cases of slight separation, if a speedy cure were specially desirable.

But the pivot of the whole matter lies in the absolute accuracy and completeness of the asepsis. Without this, the risks are unchanged. Any defect or imperfection in this regard, whether from ignorance, from carelessness, or from mere inadvertence, may lead to the most serious disaster. The surgeon, therefore, who opens the knee-joint, or operates in its close neighborhood, does so in absolute dependence upon the thoroughly aseptic condition of the parts concerned, as well as of his hands, instruments, appliances, and dressings; and the risk of failure in this essential point should forbid the recognition of operative measures as the routine practice in simple fracture of the patella.

For I cannot agree with those who assert that the results obtained by the less brilliant methods are on the whole unsatisfactory. During thirty years of hospital and private practice, it has often occurred to me to have three or four cases of this kind under my care at one and the same time; and I am very sure that some at least of them would have again sought relief, if they had found themselves permanently crippled. Of my private cases I can say positively that not one has failed to get good use of the limb. I have repeatedly seen old fractures of the patella which, according to the patients themselves, gave no trouble. And in view of the frequency of these injuries, it seems to

[1] New York Med. Journal, July 17, 1886.

me that unsatisfactory results, if as common as they are now claimed to be, would be matters of constant observation.

In conclusion, I think that in ordinary simple fractures of the patella the treatment pursued should be non-operative, but that an attempt should be made to control the quadriceps muscle, and to bring the fragments as close together as possible. The circumpatellar subcutaneous suture may be used, with the strictest asepsis, if special reasons exist for seeking a speedy union. Malgaigne's hooks, properly applied, I believe to be safe and efficient, but not time-saving. In compound fractures, where the fragments are from the outset widely separated, and especially if there is reason to suspect great laceration of the lateral fibrous tissues; when the joint is persistently swollen from effusion of blood within it; at a later period, if the prospect of usefulness of the limb is doubtful; or when in old cases the limb is actually useless, I think the opening of the joint by a suitable incision, and the suturing of the fragments and fibrous tissues, with the most careful asepsis, fully warranted by experience.

Fractures of the Bones of the Leg.

A somewhat curious case is reported by Thomson.[1] A heavy man fell from a height, alighting on his feet; at his death a week afterward it was found that the tibia had given way at two points, and that the sharp upper end of the middle fragment had acted as a wedge, splitting the upper into two principal portions; the head of the bone was broken up into five fragments, apparently by the impact of the condyles of the femur.

Additional cases of tearing off of the tubercle of the tibia have been recorded by Will,[2] by Müller,[3] and by Landsberg.[4] Besides his own, which was noted in Bruns's clinic, Müller cites six other instances, observed by Lauenstein, von Pitha, Vogt, Sistach, Weinlechner, and Stabell. In seven of the total of nine, the accident occurred to young men from 16 to 18 years of age, in the act of vaulting. In two, Will's and Landsberg's, the fragment was reduced and secured in place by a metal pin; both made good and rapid recoveries. In the other seven, the treatment seems to have consisted simply in the use of retentive apparatus, and was very successful in five; the remaining two were old cases when seen by von Pitha and Sistach.

Hodges[5] has recorded a case of compound green-stick fracture of the tibia, in a boy aged 6 years, from the passage of a wheel over the limb; there were a transverse and two vertical fissures. A good recovery ensued by the thirtieth day.

Separation of the *upper epiphysis* of the tibia, in a boy aged 8, whose case is reported by Heuston,[6] was followed by acute synovitis of the knee-joint, and seven months afterward by suppuration, which was successfully treated by erasion and by drainage through the popliteal space. Compound disjunctions of the *lower epiphysis* have been re-

[1] London Med. Recorder, July 15, 1885.
[2] British Med. Journal, Jan. 22, 1887.
[3] Beiträge zur klin. Chirurgie, 1888, Bd. iii.
[4] Centralbl. für Chirurgie, 28 Sept., 1889.
[5] New York Med. Journal, Oct. 10, 1891.
[6] Lancet, June 29, 1889.

corded by Albec[1] and by Clark,[2] who refers to sixteen other published cases.

Instances of non-union in early life have been reported by Bradford[3] and by Parker.[4] In the latter case, after nearly three years of treatment, amputation was performed. I myself saw at the Pennsylvania Hospital, in 1889, a girl only 13 months old, with pseudarthrosis of both bones about an inch and a half above the ankle; the mother stated that the child had in some way been caught under a street-car about six weeks before; there was a small sinus probably communicating with the false joint. The mother was anxious that I should operate at once, became impatient because I wanted to get the child in better condition, and took her away. Berger[5] saw a man aged 57, who when nine months old had a fracture of the bones of the leg, with pseudarthrosis, and failure of development of the limb; there was a regular capsular ligament connecting the fragments, lined by synovial membrane. The skin over the toes was anæsthetic and congested.

A curious idea is said[6] to have been carried out with success by Hahn, in an ununited fracture of the tibia. He cut through the fibula, and implanted its lower portion into the upper fragment of the tibia. It is stated that "there was scarcely any movement of the lower fragment of the tibia."

Padieu[7] relates the case of a woman who sustained a fracture of both bones of the leg, just after becoming pregnant; union failed to occur until after her confinement, when it began at once, and in a month was complete.

Mere deformity sometimes calls for operative interference. I have myself chiselled away a wedge from the tibia, united at an angle salient inward, in a boy aged 15, with good result. Jones,[8] in the case of a boy aged 16, who eleven years before had sustained a Pott's fracture, excised the inner malleolus and upper surface of the astragalus, corrected the deformity, and effected a cure with a movable joint.

In a case reported by Ashhurst,[9] an enormous mass of callus formed at the seat of fracture, both bones of the leg having been involved, and caused bowing outward, with excessive pain from pressure upon the nerve; removal of the callus was effected, with a good ultimate result.

Fractures of the upper part of the *fibula* have been observed by Weir,[10] by Marchant,[11] by McCosh,[12] and by Chapin[13] (in a boy only 6 years old). In one of McCosh's cases, in Weir's and in several instances cited by him, and in Chapin's, the bone gave way to muscular force. In Weir's, Marchant's, and several others, the external peroneal nerve was damaged, pinched between the fragments, or stretched by exuberant callus. The symptoms so produced have been discussed by Blin and Damaye,[14] in connection with a case in which paralytic anæsthesia was

[1] Transactions of Maine Med. Association, 1886.
[2] Glasgow Med. Journal, November, 1886.
[3] Boston Med. and Surg. Journal, April 12, 1888.
[4] Medical Times, Jan. 17, 1885.
[5] Lancet, May 8, 1886.
[6] Practitioner, Aug., 1884, from Centralblatt für Chirurgie, 24 Mai, 1884.
[7] British Med. Journal, Nov. 5, 1887.
[8] Ibid., March 13, 1886.
[9] Medical News, June 20, 1891.
[10] New York Med. Journal, May 26, 1888.
[11] La France Médicale, 21 et 23 Février, 1889.
[12] Med. Record, Nov. 15, 1890.
[13] New York Med. Journal, Sept. 12, 1891.
[14] Des troubles nerveux consécutifs aux fractures de la tête du péroné; in Nouvelle Iconographie de la Salpêtrière, tome i., 1888.

the principal phenomenon. They regard the condition as amenable to electricity, unless the cause is mechanical, when an operation is required for its relief.

It has been suggested by Lane[1] that fracture of one or other malleolus, by forcible rotation of the astragalus in a horizontal plane, may not unfrequently occur, but escape recognition by reason of the non-displacement of the fragments. He adduces in support of this idea three specimens obtained by him in a limited number of dissecting-room subjects; in one both bones were concerned, in one the outer, and in the third the inner malleolus alone.

In a case recorded by Jones,[2] a man, aged 29, sustained a fracture of both bones at the junction of the middle and lower thirds of the leg; on the ninth day a small traumatic aneurism was detected at the seat of injury; compression of the common femoral artery was instituted on the eleventh and twelfth days, with entire success. Exactly which vessel was thought to be involved, the account does not state. In another instance, reported by Borcheim[3] the posterior tibial artery was concerned; ligation of the superficial femoral was performed, and recovery, with union of the fracture, took place readily.

Fractures of the Bones of the Foot.

Fracture of the Astragalus.—Humphry,[4] in the case of a boy, aged 16, who fell on his feet and sustained a longitudinal fracture of this bone, removed the outer fragment by a secondary operation, suppuration having occurred; the result was favorable.

Fractures of the Calcaneum.—Gussenbauer[5] has reported the case of a man, aged 49, who fell into a ditch, alighting on his feet, and fracturing one calcaneum; tenotomy was performed, and the fragment was brought down and secured in place by a metal pin, which was taken out at the sixth week.

Two cases of fracture of both calcanea have been reported by Wight.[6] In one, in a man aged 50, complete recovery took place; in the other, in a man of 25, amputation became necessary in one foot, but good union resulted in the other.

[1] Guy's Hosp. Reports, vol. xxix., 1887, p. 395. [2] Lancet, April 19, 1890.
[3] Med. Record, Dec. 30, 1882. [4] British Med. Journal, Sept. 26, 1885.
[5] Prager medicinische Wochenschrift, 2 Mai, 1888.
[6] Brooklyn Med. Journal, Jan., 1888.

DISEASES OF THE BONES.

BY

CHARLES W. DULLES, M.D.

LECTURER ON THE HISTORY OF MEDICINE IN THE UNIVERSITY OF PENNSYLVANIA, SURGEON TO THE RUSH HOSPITAL, SURGEON FOR OUT-PATIENTS TO THE PRESBYTERIAN HOSPITAL, PHILADELPHIA.

PRELIMINARY REMARKS.

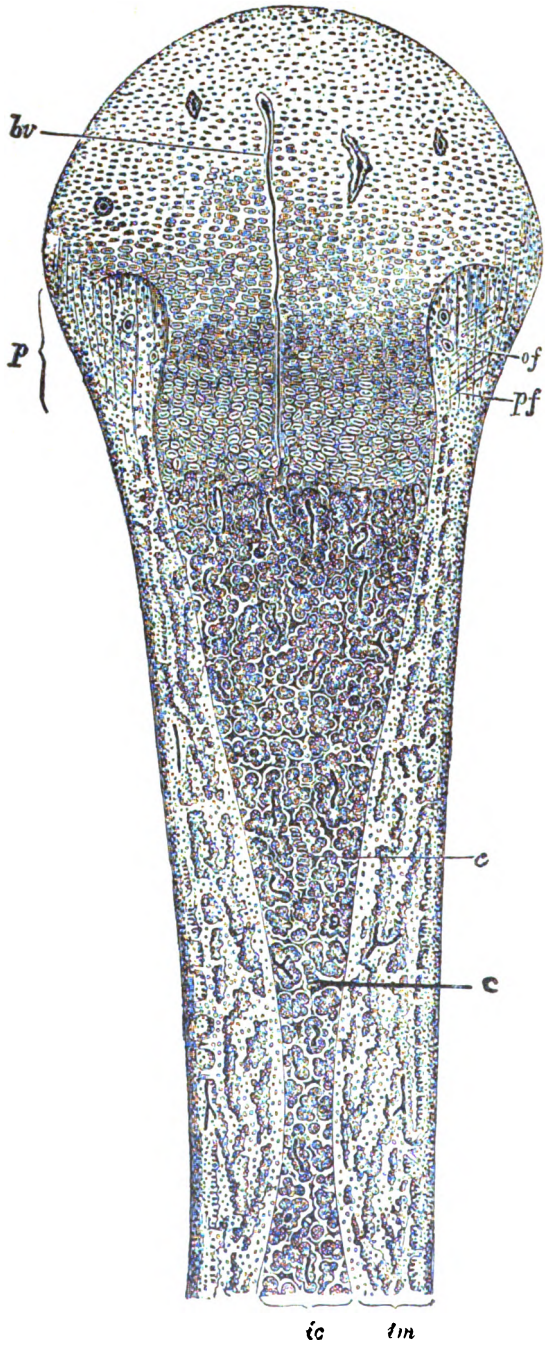
A COMPREHENSIVE study of the surgery of the skeleton would include a consideration of all the deviations from the normal state to which its various parts are liable, including (A) deformities, by defect, by excess, or by distortion (congenital, or acquired as the result of disease, accident, or surgical procedure); (B) defects of nutrition and development; (C) strains; (D) contusions; (E) wounds and fractures; and (F) the different diseases which may affect any part of a complete bone—the periosteum, the solid or cancellated tissue, or the medulla.

Certain of these are treated of in other articles of this volume, and I shall, therefore, limit the present study to a consideration of what may be considered specifically as diseases of the bones.

Before taking up the study of these divisions of the subject systematically, it may not be amiss to rehearse briefly a few facts in regard to the structure and function of the bones.

The formation of bone in vertebrates begins at a very early stage in embryonic life, among the earliest recognizable structures being the rudiments of the vertebræ and the base of the skull, which are distinguishable only by their situation and shape from the other structures to be formed out of the mesoblastic layer. They soon acquire a certain degree of hardness and a cartilaginous character, afterward undergoing ossification by the deposit of various salts, and the transformation of their cartilage-cells into bone-cells. Some of the flat bones are often cited as exceptions to the rule of development from cartilage, and are called (*quoad hoc*) intramembranous, as contrasted with intracartilaginous bones. But this is a question of terms; for all bones are developed from the same layer of the germinal vesicle, and they may, by nature or by disease, demonstrate their similarity of capabilities with other structures formed from the same layer, as is seen in the familiar instance of the bony structure of the tendons of fowls, and in the development of osteophytes. The base of the skull is, like most of the bones, developed from cartilage; the sides and roof are mostly developed within a membrane. In both varieties, the formation of com-

Fig. 1612.



Longitudinal Section of Decalcified Humerus of Fœtal Sheep. Magnified 30 diameters. (Quain.) *bv*, Blood-vessel; *p*, subperiosteal (intramembranous) layer encroaching on cartilaginous end; *of*, osteogenic fibres; *pf*, interlacing fibres; *c*, groups of cartilage-cells; *ic*, bone formed in cartilage; *im*, bone formed in membrane.

pleted bone tissue takes place from centres of ossification and proceeds until the full stage of development is reached.

A typical bone is made up of a covering which is called periosteum, a compact layer, and a cancellated layer, which is in part occupied by a cavity, called the medullary cavity, for the lodgment of the medulla (marrow). When one bone is connected movably with another, the two exhibit modifications of form and arrangement of their several parts, which supply the conditions necessary to the formation of a joint. This portion of a bone is called its articulating portion; and the fibrous capsule which surrounds a joint may be regarded as a modification of the periosteum, to which it is attached, and with which it blends at its points of insertion into the bone. An example of the appearance of a bone exhibiting at an early stage of development all the peculiarities just mentioned, may be seen in Fig. 1612, taken from Quain's Anatomy.

The flat bones differ from all the other bones in having no movable joint surfaces when they are fully developed; and they contain no true medullary cavity, although their cancellated structure—as, for example, in the body of the sphenoid, in the scapula, and in the ilium—may occupy a considerable part of the bone and make it relatively porous and light.

A peculiar expansion of the bone substance is found

in the articular portions of all long bones, and is one of their most interesting architechtonic features. By this distribution of the solid part of the bone a large surface is gained for the purpose of articulation, without any sacrifice of strength. The amount of substance present in a portion of the femur an inch long is practically the same, whether taken from the solid part of the shaft at the middle or from the open meshed part near the upper or lower end. This open-meshed structure, which looks so fragile in a dry bone, not only contains as much bone tissue in a given length as is found in the denser parts of the bone, but in addition its arrangement is such that interlacing lines constitute a species of arcs and chords, by which it is strengthened in accordance with mechanical principles, similar to those taken advantage of by engineers in constructing bridges and extensive roofs, so as to secure strength without sacrificing lightness.

But this architectural arrangement makes the expanded portions of bone especially liable to diseases which may result from irritation or infection, because these parts are more richly supplied with blood-vessels, lymph spaces, and nerves, and the vital processes in them are more active than in the denser portions. For the same reason bones in general are more liable to disease in the early stages of their development. At this time the interchange of matter everywhere in the body is going on very rapidly, and infection more quickly finds its way from part to part, and irritation is more strongly propagated. This is why so large a proportion of diseases of the bones is found in the young, and why disease is found so often in the neighborhood of joints at all ages.

A correct understanding of diseases of the bones involves a full appreciation of the fact that they are not essentially different from those of any other tissues. The bones, it is true, present mechanical conditions which modify the results of such a process as that of simple inflammation, but the process involves precisely the same physiological or pathological principles, no matter where it occurs. The changes which take place in bone under the influence of disease are precisely analogous to those which are found in a soft part similarly affected. There are simple impairments of vitality, which may result in interruption of growth or weakening of structure, or actual disintegration under the influence of forces to which a proper vitality would oppose a successful resistance. Or there may be an increase of the activity of vital processes, resulting in the formation of an excess of tissue of a character showing the signs of hasty workmanship in instability and weakness, or possessing a sort of vicious disposition to rapid growth and to the deposit of material which remains permanently or for a long time in the shape of homologous excrescences. In these processes, that which is active is, of course, the living tissue, namely, each cell for itself, while the salts of lime which make up so much of the substance of a mature bone are passive and take no active part in the vital processes. Although the substance of the cells is made up of chemical molecules just as truly as are the lime salts, the cells are living individuals with characteristics which bring them out of the exclusive category of materialism—the nature of which characteristics is utterly unknown, but which we designate as vital.

The activity of these living parts of bone has its effect upon what we call the lifeless portions, in increasing or diminishing their quantity,

or in rearranging the distribution of the material of which they are constituted. The constant flow of blood and lymph through the various channels and spaces of the bone acts upon the unvitalized portions as the movements of a stream, like the Nile, the Ganges, or the Mississippi, act upon the country through which it flows, making and unmaking land by its deposits and its washings, cutting new channels and deserting old ones, and taking up or depositing material good or bad.

As the result of these processes, two large divisions of osteitis have been described, that is, condensing osteitis and rarefying osteitis, the one brought about by a deposit of an unusual proportion of bone salts, with resulting increased density and generally hardness—eburnation; the other brought about by a solution of the bone tissue and removal of bone salts, which result in increased porosity and fragility—osteoporosis. But this is a purely mechanical distinction. So also is that which contrasts caries with necrosis: caries being a form of disintegration like that of an ulcer in the soft tissues, proceeding by the destruction of very minute portions at one time, perhaps cell after cell, while necrosis is a process in which a more or less considerable portion of tissue is deprived of its vitality at once. In bone, this results in the formation of a slough, which is called, according to its situation, a sequestrum or an exfoliation. The sloughing process in soft tissues is sphacelus or gangrene.

Modern terminology, however, ignores the mere results of pathological processes, in the matter of classification, and is constructed in accordance with the processes or causes of disease, and not with the appearance of their work.

An etiological or ontological classification of diseases and disorders of the bones might be made as follows:

A. Disorders of development (deformities).
B. Disorders of nutrition (dystrophies).
C. Disorders of physiological processes (diseases).

A. Disorders of Development (Deformities).

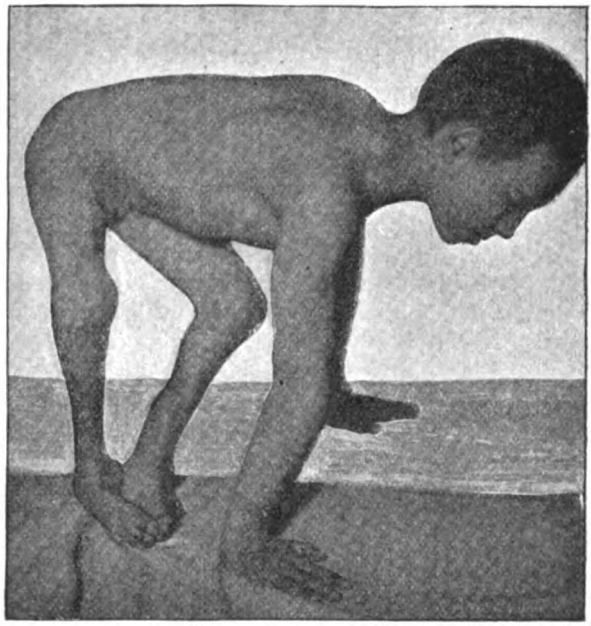
Disorders of development are purely mechanical variations from the normal standard, taking place before or after birth, and consisting in relative excess, diminution, or irregularity of development. The results of these disorders are: (1) deformities by excess, (2) deformities by deficiency, (3) deformities due to irregular (heterotopic) development.

I shall not undertake any discussion of those diseases of the bones which come under the head of disorders of development, according to the classification proposed in this article. Deformities due to antenatal defects of development are of very large variety, and are systematically discussed in works on teratology. Indeed, it is very hard to do more than refer to them, because their varieties are so numerous and so remarkable. Deformities occurring after birth belong to a different class of affections, and as the results of traumatism or pathological processes are considered elsewhere.

B. Disorders of Nutrition (Dystrophies).

Disorders of nutrition include all forms of atrophy or hypertrophy, or of unequal growth, due to interference with the normal process of nutrition, whether caused by mechanical influences or functional disturbances. Of this class are various disorders called neurotrophic: deformities due to (1) paralysis or (2) ataxia, together with (3) acromegaly, (4) rachitis, (5) osteomalacia, (6) osteitis deformans (Paget's disease), (7) gouty and rheumatic osteitis, and (8) hypertrophy following general diseases.

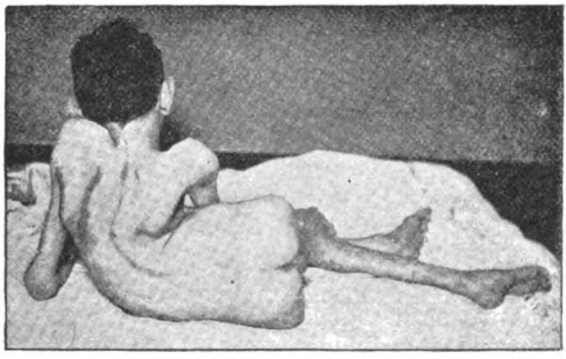
Fig. 1613.



Infantile Paralysis. Locomotion on all fours. (Willard.)

I. Deformities from Infantile Paralysis. —Many cases of infantile paralysis of the extremities have, as one of their features, a suppression of the proper growth of the hard as well as of the soft parts of the body. This defect of growth is usually uniform and universal in any part, although at times it is irregular. In some cases the degree of defective development is very remarkable. The same is true of the results of what is known as cerebral spastic paralysis. The ordinary infantile spinal paralysis consists in an anterior poliomyelitis with changes in the anterior column of the cord. Cerebral spastic paralysis is a condition in which there is loss of energy of motor cells in the brain. In infantile spinal paralysis, there are atrophy, paralysis of muscles, and impairment of the nutrition of the bones, partly from inaction, and partly as a direct result of the lesion in the nerves or nerve centres. In the spastic form of paralysis there are rigidity, paralysis with muscular spasm, irregular con-

Fig. 1614.



Excessive Lateral Curvature with Rotation: legs absolutely useless from infantile paralysis. (Willard.)

tractions, and comparatively little wasting of the limb. An interesting example of the appearance of a child who has suffered with infantile paralysis is seen in the accompanying illustration, taken from a paper read by Dr. De Forest Willard before the American Orthopædic Association in 1891. (Fig. 1613.)

Another is furnished by the same author, showing general distortion, including curvature of the spine—lordosis. The patient, a boy, could not rise, but was compelled to lie on the floor or bed, and had extreme flexion of the thighs and knees, with talipes of both feet. (Fig. 1614.)

II. OSTEITIS IN LOCOMOTOR ATAXIA.—In locomotor ataxia, spontaneous fractures of bones often occur. These are dependent upon a form of osteoporosis, which results from the nervous disorder present, and of which the bone disease is usually regarded as simply a manifestation. The bones in such cases are spongy and friable, as seen in a case described by Richet, in which a man broke his femur while pulling off his boots. Voisin speaks of a man who in four months broke, without appreciable cause, his clavicle, and both bones of the leg at the upper third. Hagen recorded in 1876 an observation of three successive fractures of the same bone. Blanchard found in bones of this sort the lesions of rarefying osteitis. According to Charcot, this form of bone disease is dependent upon disease of the medulla spinalis, and especially of the anterior horns, in both infantile paralysis and progressive muscular atrophy, and in the osteo-arthropathies of the tabetic. He thinks also that the spinal ganglia may be affected in such cases. Westphal and Seeligmüller attribute only a moderate importance to disease of the medulla, but think that the nerve lesion is situated rather in the part close to the origin of the pneumogastric nerves.

It has been noted that osteo-arthropathies sometimes follow lesions of peripheral nerves, and lesions which injure a nerve rather than those which completely divide it. Injury to a nerve-centre or to a nerve results in an interference with the normal progress of nutrition in the bones, and in a deposit of fat in place of healthy osteoblasts—a process analogous to the fatty degeneration which takes place in muscular fibres. In brief, the change is one of osteoporosis, which is fully described in the articles of Ollier, Vincent, and Poncet, in Vol. III.

Attempts to produce by means of experiment such results as are seen in ataxia have failed, although simple atrophy has been brought about; and this corresponds to clinical experience, there being very rarely any change in the bones observed after an accidental division of a nerve.

III. ACROMEGALY has recently received considerable study, without much increase of knowledge in regard to its nature, although new cases are nowadays frequently recorded. It was first described by Marie, although its occurrence seems to have been noted by Saucerotte in the last century. In this disorder, which is probably to be classed with nervous disorders, there are many manifestations of disturbance of a psychical or nervous sort, accompanying enlargement of the bones and the overlying tissues, especially of the hands, feet, and face.

IV. RACHITIS.—The subject of rachitis has been so thoroughly treated elsewhere in the Encyclopædia that not much remains to be said about it.

It has been quite completely discussed recently in a monograph by Comby,[1] whose opportunities for studying it clinically have been very large. He inclines to the opinion that the disease is the same as osteomalacia, differing from the latter only in consequence of its occurring at a different period of physiological activity. Notwithstanding this, it is well to bear in mind that a good practical definition makes rachitis to consist in a softening of bone due to deficient deposit of bone salts, while osteomalacia is a softening of the bones due to a removal of bone salts already deposited. Rickets belongs, therefore, to the period of active growth of the bones, while osteomalacia belongs to the period of maturity. Rickets is a disease of children; osteomalacia is a disease of adults or of adolescents. In fact, the latter occurs most frequently in women in connection with pregnancy or lactation. To this distinction between rickets and osteomalacia I shall in this article adhere, more for convenience than because I fail to appreciate the arguments of those who hold that the two conditions are practically the same, and that their sole difference depends upon the periods of physiological activity at which they respectively occur.

It is a disputed question whether or not rachitis is hereditary. Most authors think that it is not; and indeed it is probable that children who develop rachitis inherit nothing but a diathesis which makes them liable to this manifestation of their general weakness. Rickets has occurred before birth (intra-uterine). In such cases infants have come into the world with multiple fractures, as in a case recorded by Peter. In regard to heredity, it is a fact that many women of apparently vigorous development, with vigorous husbands, give birth to children that are rachitic; and, on the other hand, rachitic women have children whose bones are strong and well developed. At the same time there are some families in which rachitic members are found in several successive generations.

The cause of rickets appears to be bad food and bad hygienic conditions, especially during the period of nursing and in the earliest years of life. Artificial feeding is held to be responsible for a large proportion of the cases of rachitis occurring in Europe. Guillot says that the nursing bottle has killed more infants than gunpowder has killed adults. Experiments conducted upon animals have shown that deprivation of lime salts may result in softening and atrophy of the bones. Puppies fed on raw meat developed rachitis with digestive disturbances; while their brothers, who were allowed to suckle, developed naturally. The ingestion of an excess of lactic acid contributes to the development of rachitis.

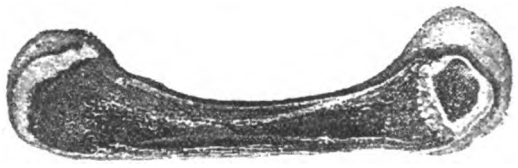
The great prevalence of rachitis in Europe and its comparative rarity in America are due to the fact that the way in which infants of the poor are sometimes brought up in Europe, differs from that in which the children of almost or quite equally poor persons in America are brought up. With us, the administration of alcohol in any form to little children is almost unknown, and—contrary to theories of digestion believed and taught pretty generally even yet—the children in our alleys who are allowed to eat bread and butter, and potatoes, and even meat, when they are very young, in many cases grow up strong and healthy, and compare favorably in weight and appearance with the children of well-

[1] Le Rachitisme. Paris, 1892.

to-do parents. In large European cities, however, it is not uncommon for children still in their infancy to be given wine or beer, which is the common drink of the parents. This, I believe, has something to do with the digestive disturbances of these children, the general impairment of their nutrition, and the development of rachitis.

No study of rachitis is complete which overlooks the serious character of the digestive disturbances which are found in this disorder. Indigestion and irregularity of the bowels and imperfect assimilation are often associated with absolute dilatation of the stomach, and with dropsy. With these there are often serious disturbances of the respiratory organs; and bronchitis, broncho-pneumonia, and spasm of the glottis are frequent accompaniments of the bony deformities seen in rickets.

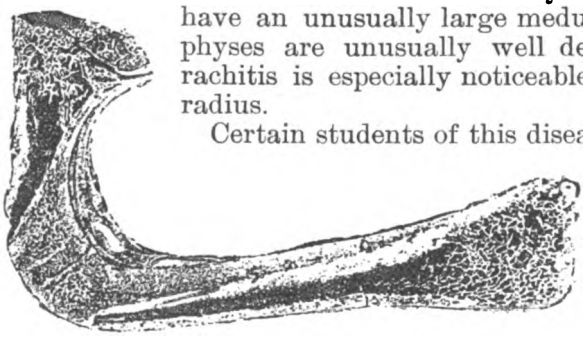
Fig. 1615.



Cancellation (osteoporosis) of Compact Tissue in Rachitis. (Lannelongue; Comby.)

In rachitis the bones are softened because the cartilage cells do not take up and dispose in the customary trabeculæ a proper proportion of the earthy salts which make up the inorganic part of a bone. In bones in which the process of growth is actively going on, bone salts are physiologically being constantly carried off while new supplies are deposited in their place; in rachitis, the process of deposit being impaired, that of removal is relatively in excess, and bones which formerly seemed of sufficient firmness lose their firmness and become more or less flexible. The appearance of a bone in which rachitis is clearly developed may be seen in Figures 1615 and 1616.

Fig. 1616.



Cancellation and Curvation of Rachitic Tibia. (Beylard; Comby.)

Such bones are unusually spongy in appearance, and have an unusually large medullary canal, and their epiphyses are unusually well developed. This feature of rachitis is especially noticeable at the lower end of the radius.

Certain students of this disease, as for example Kassowitz, look upon the process of rachitis as one of osteitis—a rarefying osteitis. This is a matter of definition, however, for the general belief is that rachitis is not an irritative disease, as osteitis is.

V. OSTEOMALACIA.—Osteomalacia, as before stated, is a disease of nutrition in which already hardened bones lose their firmness by losing their bone salts. Recent years have not added materially to our knowledge of this subject. One of the most interesting recent contributions to its literature is that of Eisenhart,[1] according to whose investigations osteomalacia is, as has already been stated, a disorder of nutrition, and not strictly a disease. It is not hereditary; it is not limited to any race, nor to any part of the world. Notwithstanding the expectation

[1] Deutsch. Archiv für klin. Med., Bd. xlix., 1892.

of Kehrer and Klebs, no bacterium has been found regularly associated with osteomalacia. Osteomalacia occurs in both sexes and at all ages, and osteitis deformans is sometimes regarded as a form of this disease. Poor nourishment, damp dwellings, and deficient clothing contribute largely to the development of the disorder. Furthermore, the use of unduly large quantities of lactic acid seems to induce the disease. All these conditions act largely through disturbances of the digestive or assimilative functions.

Osteomalacia is observed so frequently in the states of pregnancy and lactation that these are believed to predispose to or cause it. Eisenhart, however, after a careful review of the statistics of the subject, comes to a conclusion the very reverse of that just stated, namely, that persons with osteomalacia are predisposed to frequent conception. Furthermore, he finds a large proportion of cases of abortion among osteomalacic women. In 112 cases, the records of which he studied, he found 32 instances, or 28 per cent., of premature delivery by abortion or miscarriage. In regard to the blood, Eisenhart carefully studied this in a case which he describes in detail, and found that it was in a condition of moderate chlorosis, and that its alkalinity was decidedly diminished. The result of his studies brings him to the conclusion that in women certainly osteomalacia is closely connected with, and he thinks dependent upon, disturbance of the ovaries, and associated with periodical or continuous hyperæmia of the pelvic organs. This opinion is partly founded upon clinical observation, and partly upon the reported success in the treatment of osteomalacia by castration. This treatment is said to have been first suggested by Fochier in 1879, and has been specially urged by Fehling, who has secured the best results in eight cases in which he has operated. In like manner—although the explanation adopted by Eisenhart may be disputed—the Porro operation has been followed by the cure of osteomalacia. Eisenhart found, in his investigations, 8 cases of osteomalacia in men, and 12 non-puerperal cases in women, some of them girls 12 or 13 years old. Von Jaksch says that propeptone, or hemialbumose, has been found in the urine in osteomalacia, but he failed to discover it in two severe cases treated by Nothnagel.

VI. Osteitis Deformans (*Leontiasis, Paget's Disease*).—This malady was first observed by Sir James Paget, and is well described in this Encyclopædia by Vincent.[1] It is a question whether it should not be classed with rachitis and osteomalacia, all being practically similar processes, due to a disturbance of the ratio of deposit and of excretion of bone salts. Vincent inclines to this view, but Condamin finds some objection to it, because of the occurrence of hyperostosis in osteitis deformans. Pozzi has suggested for this disease the name of senile pseudo-rachitis. English investigators have traced a connection between osteitis deformans and various disorders attributed to hyperacidity, so called, such as arthritis, gravel, and gout. Some French authors have attributed considerable importance to the presence of rheumatism in certain cases. Schiff has caused somewhat similar disturbance of the bones by section of the nerves, and there is not wanting a writer—Hutchinson—who attributes the whole to the work of a bacterium.

[1] Vol. III, page 865.

VII. RHEUMATIC OSTEITIS.—Rheumatic disease of the bones is peculiar in its cause rather than in its effects. The disorder is usually propagated from the joint-structures to the bones themselves, and results in the development of a simple osteitis, with congestion, swelling, heat, and pain upon pressure. In this osteitis there is no formation of pus or of sequestra.

The subject of rheumatic osteitis has been well studied by Adams in England and by Cadiat in France. Adams believes that rheumatic osteitis is consecutive to a rheumatic affection of a joint. Cadiat believes that it arises in the epiphyses and goes from these to the joints. The truth is, probably, that the first seat of the disease is sometimes in one place and sometimes in the other.

Nothing in the cause of rheumatism explains its effect upon the bones, but this is equally true in regard to its effect upon the fibrous and serous tissues, in which also it produces swelling and pain, and often permanent alterations of structure.

Gosselin has described three forms of rheumatic osteitis: (1) rheumatic osteitis of the long bones without arthritis, (2) osteo-periostitis of the extremities with arthritis, (3) rheumatic osteitis of the flat bones.

VIII. HYPERTROPHY FOLLOWING GENERAL DISEASES.—The occurrence of hypertrophy following certain fevers is comparatively rare, but is seen often enough to make it deserving of study, although the process is rather a physiological curiosity than one inviting or requiring medical interference.

C. DISORDERS OF PHYSIOLOGICAL PROCESSES (DISEASES).

Disorders of physiological processes include all disturbances of bone which are generally known as diseases proper, such as the various forms of periostitis, osteitis, and myelitis, as well as tumors. These are, according to our present views, most accurately classified, not according to their manifestations, but according to their causes. Thus periostitis is not a disease in itself, but a manifestation of disease.

Of diseases of the bones we have those which are occasioned (1) by traumatism, (2) by neuroses, and (3) by infective agents (parasites), together with (4) forms of new growth generally designated as tumors. The articles of Ollier, Vincent, and Poncet, in this Encyclopædia, have described the processes of the various manifestations of bone disease so thoroughly and so well, that it is not necessary to discuss them again.

I. OSTEITIS DUE TO TRAUMATISM is of quite common occurrence. All surgeons who treat large numbers of ambulatory patients must be aware of the frequency with which blows and strains are followed by enlargement and pain of the bones. They also see from time to time interesting cases of deformity caused by increased growth due to osteitis, occurring especially in adolescents. These deformities are not uncommon in connection with fractures, and with strains transferred from the muscles at their points of insertion, in the periosteum and the underlying bone substance. Such traumatisms in the leg bones

may result in curvatures and twists upon the long axis of the bone, and may produce a species of deformity, the nature of which is unmistakable when once it has been seen and properly interpreted.

Fractures in which the fracturing violence carries with it some contusion of the bones, are in very many cases followed by persistent enlargement at or near the point of fracture, which may be misunderstood by patients and their friends, or even by surgeons, to such an extent as to lead to unpleasant reflections upon the skill of the surgeon, or even to suits for malpractice. In fractures at the lower end of the radius, it is very common to see what we may call a contused fracture (to coin an expression); and doubtless some cases described as impacted fracture in this position are cases of simple contusion in which, of course, the canals of the spongy tissue at the expanded extremity of the bones are broken. Contusion, in the sense in which it is found in the soft parts, is not possible in an organ made up of rigid walls with soft contents; but in the cases of which I am speaking there is no separation of any part of the bone from the main portion, and therefore no fracture in the ordinary and common sense of the term.

Traumatic osteitis is sometimes observed near the seat of fractures in consequence of irritation applied after the occurrence of the fracture. Such irritation may be the effect of the use of unsuitable apparatus, or of unwise manipulation. The rather widespread impression that so-called traumatic swelling is inevitable in most cases of fracture, certifies to the frequency with which these injuries are treated in a way to increase the physiological excitement really inseparable from their occurrence; and the freedom from swelling and pain which may be secured in most simple fractures testifies to the fact that such swelling—and inferentially osteitis—is occasioned either by an unusual degree of local traumatism, or by subsequent irritation of the part.

In this connection it is probably hardly necessary to speak of the fact that traumatisms of the bones constitute a very common mode of furnishing admission to various infective agents; so that what was originally a simple traumatic osteitis may in a short time become a very serious infective osteitis.

II. Neurotic Osteitis.—Disorders of the bones due to pure nerve influence belong properly under disorders of nutrition, and have been referred to in that place. It is doubtful if the processes observed and called osteitis in nervous disorders sought to be spoken of as such, since they are free from inflammatory symptoms.

III. Infective Osteitis.—Under this head may be considered the largest number of, and the most interesting, cases of disease of the bones. The history of this subject is comparatively recent; because, whatever suspicions have been entertained in times past in regard to the possible causation of diseases by living parasitic agents, it is only of late that the study of this hypothesis has been conducted with the means and by methods calculated to make it exact and extensive.

The principal forms of infective osteitis are infectious osteomyelitis, tuberculous osteitis, leprosy of the bones, syphilitic osteitis, hydatids of the bones, and actinomycosis.

Infectious Osteomyelitis.

The nature of infectious osteomyelitis is now quite well understood, especially since the investigations of Lücke, Klebs, Eberth, Schüller, and others. A large number of observations have been followed by a large number of experiments upon lower animals, in which cultures of certain bacteria, especially the staphylococcus pyogenes aureus and albus, have been introduced into bone, with the result of producing typical osteomyelitis. One of the most interesting contributions to the subject was made by Rodet, of Lyons, in 1884.[1] In his experiments Rodet made intravenous injections of the pus of infectious osteomyelitis, or of a culture fluid obtained from it; and in eight out of fourteen cases produced juxta-epiphyseal osteomyelitis. In one of his experiments he used a culture of the thirteenth generation and produced osteomyelitis of both femurs, one tibia, and one humerus. The osteitis observed by Rodet was usually of the rarefying sort, but in a few cases it was condensing osteitis. In 1886, Widmark, of Stockholm, concluded, from experiments made with the streptococcus pyogenes and the staphylococcus, that the former excited limited inflammation, while the latter caused inflammation of an erysipelatous type. However, many experiments and careful observations by different investigators have apparently clearly established the fact that the cocci found in infectious osteomyelitis are not peculiar to this disease, but are common excitants of suppurative inflammation, causing abscesses wherever they are operative. The peculiar features of osteomyelitis depend, therefore, not upon the agent by which it is excited, but upon the anatomical and physiological characteristics of the organ in which it occurs. Interesting details on this subject can be found in a number of works on pathology; here I must content myself simply with stating the final result of investigations on this subject, namely, that this form of osteitis is occasioned by the presence in the bones of one or other of the forms of bacteria known as staphylococcus pyogenes aureus, citreus, or albus, and the streptococcus pyogenes; and that there may be found in the inflammatory product the pneumococcus and the bacillus of typhoid fever. These latter have been looked upon as causing osteomyelitis, but this is not clearly demonstrated.

The mode of entrance of the infective agent in osteomyelitis may be direct, in consequence of a wound exposing the bone—a very rare mode of infection—or the micro-organisms may reach the bone tissue by the route of the circulation. As in other infective diseases, it is believed that these organisms may lie inactive in, or pass inactive through, the bone, without exciting inflammatory action until something which acts like a traumatism—a real traumatism, or a shock from cold, or the lowering of the power of the tissues by disease—prepares a condition in which the specific micro-organism develops its full activity and sets up an active malady. This is the view entertained largely by German investigators, but Lannelongue asserts that no case of osteomyelitis can be found in which there is not—even though it be not discovered—some excoriation of the skin or mucous membrane by which the germ may effect an entrance to the circulation. For my own part I may

[1] Revue de Chirurgie, 1885.

say, in the first place, that this supposition is merely a surmise, founded upon *a priori* grounds; and, in the second place, that it ignores the fact that the germs which excite osteomyelitis also excite suppurative inflammation in other parts of the body, and that it is unlikely they should elect the bones at a distance from the point of entrance, and leave no noticeable trace of their action at this point, or anywhere between it and where the bone disease develops.

It has been asserted that these organisms may effect an entrance through the unbroken skin by the route of the hair follicles and sebaceous gland ducts, as happens in the case of the staphylococcus of furuncle and of carbuncle. But this again is a matter of surmise. The most probable route of entrance is the mucous membrane of the respiratory tract or digestive tract, and probably at some point where there is weakness or lesion of their epithelial lining.

Once admitted to the system, cocci may proceed without noticeable manifestations to the bones where—usually in the epiphyses—they find a convenient habitat, in which they multiply, and where they set up the characteristic lesions of infective osteomyelitis. Such outbreaks are in some cases preceded by collections of pus in other parts of the body, in which the staphylococcus may be found. In such collections it has been observed that, the more chronic the process and the less constitutional reaction there is accompanying it, the more likely it is that the coccus found will be of a lighter color: that is, the mild forms of the disease are associated with the staphylococcus pyogenes citreus or albus, while the graver and more acute forms of infection are accompanied by the staphylococcus pyogenes aureus. Lannelongue and Achard, in 1890, reported to the Société de Biologie a series of experiments which seemed to demonstrate the relative degree of virulence just described.

Certain conditions are probably necessary to infection with the bacteria of osteomyelitis: some lowering of the tone or condition of the system, or some excitation like that of adolescence, or some traumatism. This may be of so slight a character as to escape particular attention, but it is probably present in every case. In addition to the three forms of staphylococcus referred to, it has already been mentioned that osteomyelitis may be produced by the action of the streptococcus pyogenes; although Ullmann asserts[1] that it has heretofore never been found alone in the pus of osteomyelitis. Unmistakable forms of infectious osteomyelitis are occasioned by the bacillus pyocyaneus, as also by the micrococcus tetragenus, and the bacillus prodigiosus. Ullmann, in four attempts to produce osteomyelitis by subcutaneous injection of an emulsion of bacillus prodigiosus, succeeded in every case.

The occurrence of inflammatory disease of the bones after typhoid fever is by no means uncommon, and such inflammation has been attributed to the presence of the bacillus of typhoid fever. This bacillus has been found in the pus of osteomyelitis under such circumstances, and in some cases is said to have been found unaccompanied by any other coccus or bacillus. Ullmann reports thirteen experiments—twelve on rabbits and one on a dog—with an emulsion of typhoid bacillus; and in four of the rabbits and in the dog he succeeded in producing the lesions of osteomyelitis.

[1] Osteomyelitis Acuta. Wien, 1891.

In rare cases, osteomyelitis is produced by the action of the pneumococcus; but the cases so far observed are so very few that there has been little opportunity to study this form of osteomyelitis. Ullmann had no difficulty in producing the disease by injecting pneumococci after preliminary fracture of the bone. Achard reported, in 1890, a case of osteomyelitis caused by pneumococci.[1] Petrone and Fournier have described a form of osteomyelitis occurring in gonorrhœa, and attributed to the activity of the gonococcus, but Ullmann's attempts to produce the disease experimentally, failed entirely.

The streptococcus of erysipelas is by certain pathologists regarded as identical with the streptococcus pyogenes. Senn[2] distinguishes between them, and cites, with apparent approval, Hajeck's assertion that the streptococcus erysipelatosus is found within lymphatic vessels, while the streptococcus pyogenes penetrates the tissues very deeply, and migrates beyond the lymphatics. The latter also, is found in connection with blood-vessels, the former is not. Senn holds to the view of Fehleisen that these forms of streptococcus are not identical. Ullmann's experiments in regard to this subject tend to a different view. He succeeded in producing experimental osteomyelitis with cultures of the coccus of erysipelas; while on the other hand Meierowitsch produced erysipelas with the streptococcus pyogenes.

Osteomyelitis has been observed a certain number of times after an attack of smallpox; but its exact nature is not any more clearly understood than that of variola itself. Similarly, a few cases have been reported as following measles and scarlet fever, and influenza.

The sum of our knowledge in regard to experimental osteomyelitis may be expressed in the language of Ullmann, as follows: "A disease like osteomyelitis can be produced in animals by introduction into the circulation, or into the bones, of pus-producing organisms, after having injured the bone. This may be done with any form of bacterium which has the property of producing pus. If experiments of this kind are carried out with successful aseptic precautions, the micro-organisms found in the pus are identical with those used in the experiment. In man, the most commonly present micro-organism is the staphylococcus; but other forms of bacteria may undoubtedly produce osteomyelitis. The mode of access of the micro-organism may be through the skin or mucous membrane, probably at some injured point. Osteomyelitis is not a specific disease any more than an abscess is of itself specific. It is ordinarily produced by micro-organisms, but may be produced experimentally without them."

If this statement be accepted, it will be seen that part of our definition of osteomyelitis is set aside; for we have been speaking of "infectious" osteomyelitis; and, of course, osteomyelitis without infection belongs to a different category. Ullmann produced true osteomyelitis by the injection of calomel into the veins of a dog and two rabbits. In these, the symptoms were perfectly typical, including painful swelling and suppuration; and the pus being carefully examined both microscopically and by bacteriological culture methods, showed no bacteria. This result corresponds to the subcutaneous abscesses or diffuse infiltrations of pus produced by Chotzen by subcutaneous injections of calomel. Ullmann caused osteomyelitis also by injecting turpentine into the medul-

[1] Bulletin Médical, 24 Août, 1890. [2] Surgical Bacteriology. Philadelphia, 1889.

lary cavity in two dogs. In these cases also the pus contained no bacteria.

PATHOLOGICAL ANATOMY OF OSTEOMYELITIS.—There are four stages in a typical attack of acute osteomyelitis; the first is that of localization of the infectious or exciting agent. This is a period not subject to observation, and one about which practically nothing is known. The second stage is that of the local outbreak, consisting in the ordinary process of inflammation in the bone, that is, in the medulla of the bone. After this, the inflammatory process passes to the third stage, that of encapsulation of the abscess, and the formation of sequestra. The fourth stage is that of repair, which corresponds precisely to that of other forms of osteitis in which there is dead material to be carried away or extruded from the body, and in which the products of hyperactivity of the tissues are to be disposed of.

In the second stage, that of purulent infiltration, there is an inflammation of the bone marrow which is not distributed over a large surface, but is strung along in multiple foci in which the hyperæmia is well-marked; and in addition there are often small extravasations of blood. These are usually in proportion to the severity and extent of the attack. The foci of inflammation break down by the formation of pus, and this process progresses in the direction of the junction of the diaphysis with the epiphysis, and toward the periosteum, which is infiltrated and often elevated by the inflammatory products, forming swellings of greater or less size. The extent to which the periosteum is elevated usually marks the extent to which the inflammatory process has gone in the interior of the bone. From the periosteum, the products of inflammation may make their way to the surface through the soft parts. The inflammatory process may also proceed to the joint ends of the bone and break down the epiphyseal cartilage. In children the disease often stops short at this cartilage, while in adults it is more likely to pass over into the articular epiphysis and even break into the joint. It is interesting to note that the progress to the joint is always from the medulla, and through the epiphysis, never by means of the periosteum exclusively. Roser has asserted that the disease may begin as an inflammation of the joint and pass from the joint to the bone. Ullmann does not share this opinion, but believes that careful examination of specimens shows that it is a mistaken one. As osteomyelitis progresses from the diaphysis to the epiphysis it frequently breaks down their junction, so that they are movable, the one upon the other. When the joint is affected, the further progress of the case is like that of other inflammations of the articulation.

The third stage of osteomyelitis is that of encapsulation and the formation of sequestra. This is ushered in by the interposition of an inflammatory barrier in the sound tissue, in which the disease does not progress. At this point, the already affected tissue is separated by absorption from the living tissue, and there is formed an abscess cavity containing pus, débris, and sequestra. On section, a bone in this stage of osteomyelitis shows bright red and dark red portions, alternating with yellow and suppurating portions of varying size and form, stretching along the medullary cavity and spongy tissue like beads upon a necklace. Toward the end of the bones there are no real abscess cavities,

but rather suppurative infiltration, the tissues being, in some places, more brittle than in others. In the wall of the bone the diseased portion is distinguished from the rest by its dirty yellow color. The amount of destruction of the bone tissue depends upon the extent to which the medulla is affected. Large sequestra are not common, because extensive disease of the medulla is usually accompanied by extensive separation of the periosteum, with accompanying necrosis of the whole thickness of the bone, and no possibility of the formation of a shell to constitute an involucrum. In this stage, the inflammatory products may excavate the bone to such an extent as to leave the sequestrum in a large cavity, or it may be closely in contact with the walls.

The pus in osteomyelitis frequently breaks through the surrounding bone and escapes by way of a fistula, which may be broad and straight, or long, narrow, and sinuous. Periosteal, or parosteal, abscesses often communicate by long fistulæ with the cavity in the bone.

In persons in whom the epiphysis is not solidly united to the diaphysis, separation of these two parts is not uncommon. This is possible usually to about the age of twenty years, and in exceptional cases for ten years later. Separation is most common at the upper end of the tibia, or at the lower end of the femur. It occurs so frequently that it has been proposed to call the disease "inflammatory separation of the epiphyses." The affection in the joint leads to the formation of pus, which is sometimes thin and transparent, or semi-transparent. The synovial membrane is injected, eroded, and ulcerated.

The several successive stages of osteomyelitis may be observed in the same bone in consequence of successive infections at different points.

The fourth stage of osteomyelitis, or the stage of repair, consists in the separation of the sequestra, and their spontaneous or surgical removal. In this stage, the infective process, as such, is at an end, and there remain only the usual phenomena of the extrusion of unfit material, and the filling up of defects by granulation tissue. The destruction of sequestra is effected by the action of the living tissues—the granulations which surround them and erode them carrying off into the circulation their constituents—and not by any chemical action of pus in these cavities. In the case of cartilage, it seems that pus may dissolve isolated fragments. On the surface of the bones, the process of repair is carried on by the periosteum, in the way in which it is carried on in all forms of osteitis. It is noticeable that the newly formed bone is more adherent to the dead bone than to the periosteum itself; so that there is some danger, in removing dead bone, of removing the living bone with it unless this fact is carefully borne in mind. In this stage, the medulla is not in a condition of diffuse suppuration, though it may contain isolated and encapsulated abscess cavities. The degenerated medulla is regenerated with considerable rapidity. This regeneration takes place in part from the periphery, and in part from the remains of the medulla occupying the ends of the bone.

For the minute details of the various processes of osteomyelitis, the reader may refer to the admirable work on this subject, of Ullmann, cited above. These details may be summarized, however, as follows: The changes in the bone tissue consist in a neoplastic bone formation, with the formation of new vessels and of medullary spaces, on the walls

of which osteoblasts are to be seen. Below the periosteum, new bone is deposited, and is characterized by having bone corpuscles larger than those of the old bone, and more irregularly arranged. While bone is being formed on one side, on the other, in consequence of inflammation, lacunæ are formed in the old bone, and it contains at certain points, grooves and furrows—the so-called lacunæ of Howship—which contain large giant cells with multiple corpuscles (osteoclasts).

The investigations of Ullmann in regard to the changes in the medulla indicate that they are the same in every form of infectious osteomyelitis, no matter how it is occasioned. These changes consist in a remarkable multiplication of cells like the white blood corpuscles, and of white cells containing red globules, or pigment granules. With this, there is a diminution of the red cells, and a peculiar change in the giant cells, with an enlargement and multiplication of the connective-tissue cells.

The increase in white corpuscles is absolute, as well as relative. Ullmann found them in from four to six times the normal number, and Schede calls attention to the excess of leucocytes, which, in some cases, amounts to an absolute leucæmia.

Symptoms of Acute Infectious Osteomyelitis.—The symptoms of an outbreak of acute infectious osteomyelitis are those which mark the outbreak of most infectious diseases. That is, there is a rise of temperature, with the signs of disordered circulation—consisting in this case of suffusion of the face with a rapid and small pulse—a coated tongue, digestive disturbances, and sometimes a fœtid diarrhœa. The evidences of general systemic poisoning are seen in these symptoms, and, in more severe cases, in the occurrence of delirium, and even of coma and death. The local symptoms are those of a painful, inflammatory process. There is a deeply seated swelling, to be felt along the line of the bone, usually from the neighborhood of the epiphysis to the middle third. A little later, over this swelling, dull redness of the skin may be found, and possibly deeply seated fluctuation. When the joint is involved, the symptoms of pain, swelling, and elevation of temperature are often found here also. In some cases, the joint pains are so much more conspicuous than those of the diaphysis, that osteomyelitis has been mistaken for rheumatism. If the swelling caused by osteomyelitis be incised, pus will be evacuated, characterized by the presence of large fat drops, derived from the medulla. A finger introduced detects the bone deprived of its periosteum, and sometimes a separation of the epiphysis from the diaphysis.

In osteomyelitis, the infection may be transferred to other parts of the body, and especially to the lungs, at first by infarcts of fat coming from the disorganized bone, and afterward by septic products, causing metastatic abscesses. Such abscesses may occur in the lungs, the kidneys, the pericardium, or the pleura.

This is the history of a severe case of osteomyelitis. But the type may be milder, in varying degrees, until it appears comparatively light. Secondary outbreaks may occur in other bones than the one first affected, and, as we have seen before, even the same bone may give evidence of secondary infection at a distance from other points of manifestly earlier infection. These different points of infection may not all

develop the same degree of severity. Ullmann cites a case of a child who, on one side, had a separation of the epiphysis of the humerus, and in the other only a thickening of the shaft of the corresponding bone. Roser reports a case of similar character. In such cases, there often remains an increase in the length of the bone which has not been affected to the point of suppuration. This increase is precisely that described by Ollier, dependent upon excitation of the physiological activity of the juxta-epiphyseal region.

An interesting feature of osteomyelitis, from the clinical standpoint, is the occurrence of *recidives*—later attacks—apparently due to the release of some infectious material, until then locked up, or to the renewed activity of some such agent until then dormant. These attacks may, of course, be caused by new and unrecognized infections; but many authors hold to the idea of their dependence upon the first attack, rather than upon an obvious predisposition to osteomyelitis of the particular patient.

Diagnosis of Acute Infectious Osteomyelitis.—The diagnosis of osteomyelitis is founded upon the symptoms already described; but, as in other diseases, variations from the typical form may obscure a decision; and other diseases may more or less simulate this one. Among those most likely to be confounded with it, is inflammatory rheumatism of the joints. To this osteomyelitis sometimes bears a close resemblance; because the symptoms of joint disease or of inflammation at the joint-end of the bone are at times more pronounced than those of the disease in the shaft, and the latter may be inconspicuous while the former are very pronounced. It is important to remember this fact in cases of severe inflammatory conditions in or near a joint, especially if there are marked signs of constitutional disturbance. The possibility of mistaking osteomyelitis for rheumatism is greater when—as sometimes happens—the disease is actually limited to the epiphysis. An error may be avoided if this possibility is borne in mind in every case, and if a careful and thorough examination of the bones is made. In a number of doubtful cases it will be found on examination that there is a spot in the epiphysis where there is localized pain on pressure, and where a skilful touch may discover a diminution of resistance, giving the impression almost of a defect in the bone.

Osteomyelitis may be mistaken for typhoid fever; but hardly, if proper attention is given to the state of the bones. Still, it must be remembered that in former days it was proposed to call this disease "typhoid of the limbs." In this connection it is well also to bear in mind the fact that osteomyelitis may be a complication or sequel of typhoid fever, and that the typhoid bacillus has been found in the pus of osteomyelitis.

Osteomyelitis should not be mistaken for primary periostitis, because their courses are not alike, and the appearance of the skin is quite different. In periostitis, the skin is usually more actively hyperæmic and reddened. In osteomyelitis, the color is more dull. Further, the change in the skin appears early in periostitis, and late in osteomyelitis. Suppuration in periostitis is not common, and is a late symptom. In osteomyelitis, it almost invariably appears early in the progress of the disease. The swelling in periostitis is more diffuse; in

osteomyelitis it is more circumscribed. Further, the implication of the joint will settle the diagnosis in favor of osteomyelitis.

Confusion of osteomyelitis with tuberculosis is quite possible. Of course, an acute osteomyelitis will not be mistaken for tuberculosis, but the chronic form may prove deceptive. Ullmann records a case in which he amputated above the knee, in a case which was thought to be one of tuberculosis; but on examination of the bones there was found an osteomyelitic abscess in the upper epiphysis of the tibia, in progress toward healing, and communicating with the popliteal space by means of a fistula looking exactly like a tuberculous opening. Albert has called attention to the possibility of confusing osteomyelitis with tuberculosis in cases in which there is spontaneous luxation of the thigh bone with a firm swelling on the metacarpus, suggesting coxitis and spina ventosa.

The confusion of osteomyelitis with pyæmia and septicæmia is not remarkable; because both of these conditions not infrequently occur in osteomyelitis, and the mistake consists in a failure to investigate the case sufficiently, and to trace the causes of the various phenomena.

Ullmann cites a case from Salomon in which osteomyelitis had the appearance of pernicious intermittent fever.

The bones which are by far most frequently the seat of osteomyelitis are the femur and tibia, and after these the humerus. All collections of statistics agree on this point. But even the flat bones may be affected, as was seen in a case under the care of Albert, in which the frontal bone was involved. The symptoms were pain in the forehead, œdema from the root of the nose to the beginning of the hair, and chemosis in both eyes. Upon opening the soft parts and trephining the bone, pus escaped.[1]

Prognosis of Acute Infectious Osteomyelitis.—The prognosis of osteomyelitis is bad, but not as bad as it was formerly supposed to be; because there was a time when no cases were recognized except the most severe, and those which naturally had the worst outcome. At present the death rate is about 25 per cent. In the majority of cases, after the disease has lasted some weeks, the manifestations of inflammation diminish, the general condition of the patient improves, the swelling of the limb lessens, and the disease assumes a rather chronic course, with the occurrence of necrosis and the formation of sequestra, or the development of bone abscesses. Necrosis takes place in about eight out of every nine or ten cases. The part of the bone to die may be the cortical portion, that is, a more or less thick layer of the wall of the bone; or the central portion, the part next to the medullary cavity, may undergo necrosis. There is a form of necrosis intermediate between these two, in which the portion of the bone between the inner and outer layers of the cortical portion dies. Ullmann describes, besides these, a form of necrosis called penetrating, in which the bone dies over a certain area, from periosteum to medulla; and a transverse necrosis, in which the bone dies over a certain area in its entire thickness.

[1] This case is reported by Ullmann, but, notwithstanding the eminence of the operator, the meagreness of detail in the report permits the thought that possibly the case was one of suppuration or inflammation of a frontal sinus.

The sequestrum of osteomyelitis is enclosed in a cavity, the wall of which is never entirely complete; for the cavity communicates with the soft parts, or even with the exterior, by a fistulous track. The sequestra of osteomyelitis are very seldom absorbed. They are sometimes expelled spontaneously, especially when small, and in other cases are removed by the surgeon. The loss by necrosis is sometimes so great that what is left of the bone is liable to fracture upon the slightest provocation. Indeed, there may occur what are called spontaneous fractures.

The discharge of pus after osteomyelitis may continue for a very long time; indeed it may go on through the whole life of the patient. In some cases the discharges are small, and inconvenience the patient but little; in others, the persistence of a fistula is followed by evidence of irritation of the nutritive processes of the soft parts, so that eczema, exuberant granulations, or even carcinoma may develop. In the bone itself, secondary bone abscesses may result from the breaking down of the new-formed tissue in the neighborhood of the original seat of irritation.

Osteomyelitis may produce abnormal increase of the length of a bone. This, as has been stated above, is the result of excitation of the nutritive processes in the juxta-epiphyseal region, so admirably described by Ollier.

Treatment of Acute Infectious Osteomyelitis.—The treatment of osteomyelitis is general and local. The general treatment is purely depurative and tonic. In all cases attention must be paid to the condition of the bowels and of the kidneys, and both should be kept gently acting. Care must be taken that the case of the patient is not prejudiced, while he is combating the poison of osteomyelitis, by the formation or retention of toxic materials in the bowels and urinary organs. The local treatment consists in rest, both general and local, the latter being absolute. The application of cold by means of a Leiter's coil, or by the use of ice-bags, is often very comforting to the patient. Ullmann approves the free painting of the part with tincture of iodine, as recommended by Demme and Billroth. The iodine should be painted on with a large brush until the skin is almost blue-black, and the area covered should be larger than that of the affected bone. The painting should be repeated every second day as long as the skin will bear it. Collections of pus must be evacuated, and the cavities must be thoroughly washed out with a disinfectant solution. In the present state of surgical science, any condition like that of osteomyelitis calls for early and thorough removal of any infectious material; therefore early incision should be practised, and thorough disinfection with solutions of carbolic acid, or chloride of zinc, or (according to my experience) tincture of iodine; after which drainage and thorough antiseptic treatment must be continued. Openings of this sort should be washed out again and again until the cavities appear to have lost the characteristics of specific inflammation. If the pus is seated in the sub-periosteal region, it is comparatively easy to evacuate it. If in the bone, the process is more difficult. In the latter case, the bone must be trephined. Kocher practises injection of the bone cavity by means of a perforator and a syringe, or by means of a trephine with

lateral openings which may be used for the injection. The openings made in the bone in such cases must be numerous. They may be made at distances of about an inch, and the trephine or perforator should be carried forward until it meets no resistance, showing that the medullary cavity has been reached. Ullmann believes that it is better to make these incisions too early than to risk postponing them too long, and prefers this mode of treatment to large and long openings with the chisel.

If only the diaphysis is diseased, it may be removed entire. The fear of a subsequent defect in the bone need not deter the operator; because the process of repair is, in many cases, remarkable. When the disease affects the epiphysis, amputation is probably the best treatment, because saving the limb without the epiphysis and its connecting cartilage, results in deformity due to interrupted growth, which is as serious as the loss of the member. When osteomyelitis affects the joints, these must be opened and the infective material thoroughly removed by excision, *évidement*, or resection. In other respects, the treatment of osteomyelitis is what would be suggested by general surgical principles; but I would lay stress upon the importance, in these cases, of considering, besides the purely surgical aspects of the case, the medical conditions presented, and the careful and continuous scrutiny of all the important organs of the body, with the use of every measure available to maintain the strength and vital force of the patient.

In the interesting paper by C. Garré, referred to above,[1] he describes what he regards as peculiar forms of acute infectious osteomyelitis. Among these, he includes what is in this work described by Poncet as *periostitis albuminosa*. This disease is so rare that Garré, examining the literature of the subject, found only 26 cases in all. Schlange, after the study of 15 cases, concluded that it was a form of infectious osteomyelitis, and in one case which he observed, he found the specific micro-organism of that disease. Garré describes two, likewise, in which he found the staphylococcus. In one case the disease was recurrent; in the other it was acute and primary. In both cases the exudate was characteristic of so-called albuminous periostitis. In the first case, cultivation produced the characteristic staphylococcus pyogenes aureus; and in the second, this form together with the staphylococcus pyogenes albus. Garré accounts for the presence of the albuminous fluid in so-called albuminous periostitis upon the supposition that there has previously been a purulent collection which has undergone mucoid degeneration, or that a small quantity of pus is mingled with a relatively large quantity of transuded serum or lymph.

In addition to the preceding, there is a subacute form of infectious osteomyelitis, which is sometimes difficult to recognize. Garré points out the fact that there may be, at two different points in the same individual, a rapidly progressing osteomyelitis and a chronic subacute variety. In such a case, in a boy 15 years old, the diagnosis depended partly on culture experiments; and their results indicated the carefulness with which such experiments must be conducted, and the danger of drawing hasty conclusions from them. In this case, the inoculation

[1] Einige seltene Erscheinungsformen der akuten infektiösen Osteomyelitis. Festschrift zum 25ten Jubiläum von Theodor Kocher. Wiesbaden, 1891.

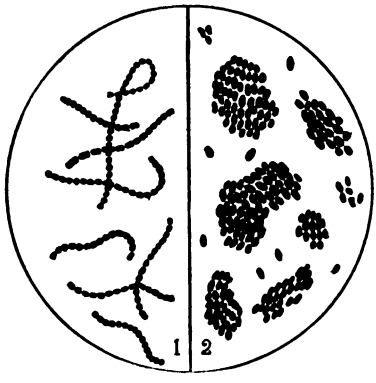
of a small quantity of pus upon gelatine gave no results. When larger quantities, however, were used, colonies of staphylococci were developed.

Garré also describes a chronic sclerosing form of osteomyelitis in which the acute symptoms are typical, and in which the disease proceeds to the stage of swelling, pain, and enlargement of the bones, even with plain infiltration of the soft parts; but in which, instead of the appearance of the expected abscess, the conditions ameliorate, and the patient proceeds to recovery, or at least, to very great improvement. Garré describes three cases of late recurrence (*recidive*) of osteomyelitis.

Tuberculosis of the Bones.

The history of tuberculosis of the bones is an exceedingly interesting one, for unmistakable allusions to what is now known by this name are to be found in the writings of those shrewd observers, the most ancient medical writers. For a summary of this history, reference may be made to the classical work of Arloing;[1] but no writer of the present time can well avoid mention of the important contributions to our knowledge of tuberculosis of the bones made by Charles Nélaton, Villemin, Chauveau, Ollier, König, Schüller, Krause, Koch, Arloing, and Gangolphe. Various theories in regard to the cause of tuberculosis of the bones, indicated by a variety of names applied to its manifestations, are to be found scattered through the literature of the subject, but the latest conception of the disease dates from the year 1882, when Koch published his investigations in regard to the *bacillus tuberculosis*, which is now regarded by almost all pathologists as the cause of tuberculosis wherever it is found. Nevertheless, using the same method of reasoning employed to identify the bacillus of Koch, there can be no doubt that other micro-organisms may give rise to a process having all the clinical features of tuberculosis, and absolutely indistinguishable from it in any other way than by the process of isolating the micro-organism present in the lesions. This is not the place to discuss this matter, which is fully and ably treated of in the admirable work of Arloing, who describes four varieties of tuberculosis produced by different micro-organisms. The first variety is that which is recognized as due to the bacillus of Koch. The second is what he calls *tuberculose zoögloeique*, or *bacillaire*, or *strepto-bacillaire*. The third is the *tuberculose bacillaire* of Courmont. The fourth is the *tuberculose bacillaire* of Preisz and Guinard. The evidence upon which Arloing bases his opinions in regard to this subject is given by him in full, and need only be referred to as like that upon which the belief in other forms of parasitic disease rests. A represen-

Fig. 1617.



Culture of *Streptobacillus tuberculosis* of Dor. (Arloing.)

[1] Leçons sur la tuberculose. Paris, 1892.

tation of the strepto-bacilli of Dor is found in Fig. 1617. The tuberculosis bacilli of Courmont are seen in Fig. 1618.

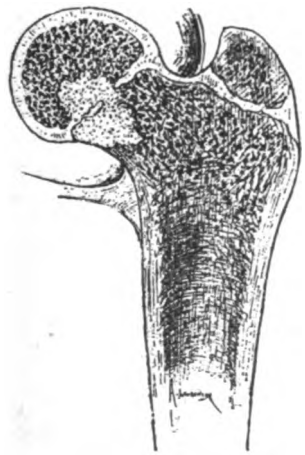
The classification adopted in this article would lead us to call all forms of tuberculosis unassociated with the bacillus tuberculosis, "pseudo-tuberculosis." In general, it may be said that the theory that tuberculosis in bone—as elsewhere—is a parasitic disease associated with the presence of the bacillus tuberculosis of Koch, rests upon a very large mass of clinical and experimental observations; although fairness requires the admission that no clinician is so experienced or skilful that he can say with certainty that a given disease of the bones, presenting typical features of what is called tuberculosis, and clinically entitled to this designation, will, on the most diligent search, supply to the bacteriologist under the microscope, or on culture media, a single bacillus of Koch. A correct understanding of these cases will doubtless come in time; for the present, it may be said that—as far as the patient is concerned—they are precisely like the cases of tuberculosis with bacilli, and that pathologists who believe in the specific character of tuberculosis assume that, in these cases, the bacilli are present in small numbers, or in the spore stage, or have been present at the outset of the disease.

Fig. 1618.

Culture of *Bacillus Tuberculosis* of Courmont. (Arloing.)

PATHOLOGY.—In studying the pathology of tuberculosis of the bones it must always be remembered that many other bacteria besides the bacillus tuberculosis are found mixed with the products of inflammation and disintegration of the tissues; also, that the bacilli of tuberculosis are hardly ever found in the old products of inflammation—caseous débris, or the contents of abscess-cavities.

Fig. 1619.



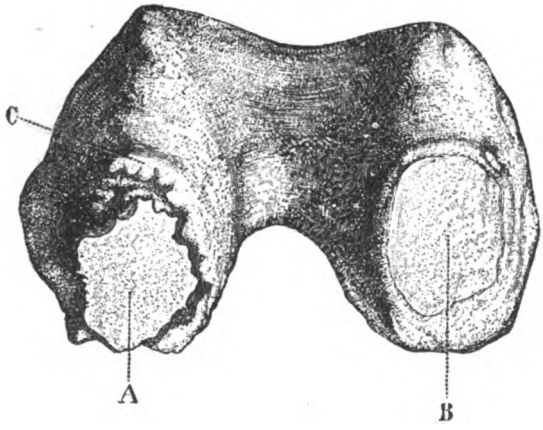
Latent Circumscribed Tubercle of Epiphysis and Diaphysis, Discovered only after Section of the Head and Neck of Femur. (Gangolphe.)

Tuberculosis of the bones is peculiarly a disease of the spongy tissue, and it especially affects bones in which this tissue is conspicuous, as for example the vertebræ, the tibia, the femur, and the humerus. In contrast to osteomyelitis it attacks the epiphyses rather than the shafts, or the juxta-epiphyseal regions. This, it must be remembered, is in general; there are exceptions to the rule.

In situation, tubercles may be deposited immediately below the articular cartilage, or immediately below the perichondrium or periosteum, or in the central portion of the epiphysis, or partly in the epiphysis and partly in the diaphysis, as seen in Fig. 1619.

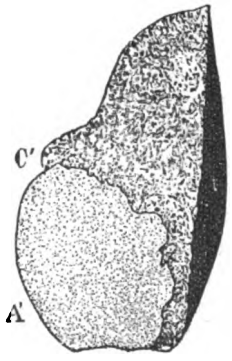
There are two forms of tuberculosis of the bones: one, in which the process is more or less circumscribed or limited by an area of comparatively compact tissue—the wall of defense which in many cases nature throws up to prevent further invasion of an inimical force; the second, a diffuse form, characterized by irregularity of distribution, often by multiplicity of foci, and always by the absence of any distinct limiting wall. The analogies between tuberculosis of the lungs and tuberculosis of a tissue entirely shut off from the outer air are interesting and striking. Even in bone, it is found that the first stage of tuberculosis is one of increasing density, due probably to irritation; softening almost invariably occurs as a secondary manifestation, just as in the breaking down of lung tissue. In the stage of hardening there are sometimes found curious points in which the process has gone on to eburnation,

Fig. 1620.



Eburnated Sequestrum of the Condyles of the Femur. (Ollier.)

Fig. 1621.



Section of External Condyle of Preceding. (Ollier.)

usually at the articular surfaces of bones. A curious illustration of this is seen in Figs. 1620 and 1621.

In tuberculosis of the bones, as in that of the lungs, giant cells are found. In both cases the distribution of the affected parts is such as to suggest the formation of infarcts. König and Müller have asserted, and reasonably demonstrated, the occurrence of such infarcts; although their belief that tuberculous deposits are generally conical, with the base directed toward the articulating surface, has not been confirmed by other investigators: in fact, the very opposite condition has been found. In the bones, as in the lungs, deposits of tubercle may exist for a long time without giving rise to serious symptoms of disease; they may also become encapsulated, or may be carried away and apparently cured by natural processes.

The large experience gained at the school of Lyons suggested to Gangolphe an investigation of the spontaneous cure of tuberculosis of the bones; but he was able to see only a few specimens in the dissecting rooms which suggested this occurrence. In twelve years he saw only two cases in which it seemed probable. He quotes Mauclaire, who found only one example in 1600 cases in which he opened the epiphyses of bones in the subjects of dissection.

The usual process in the formation of a focus of tuberculosis in bone,

is for some irritant, presumably tubercle bacilli, to provoke an excessive activity of the physiological processes, with the result of the formation, on the one hand, of imperfectly developed tissue, and, on the other hand, of hardening in the surrounding region. This is followed by solution, not only of the first-formed tissue, but also of that which surrounds it. In certain cases the limiting wall soon proves sufficient to restrict the process; in other cases this wall succumbs to the irritation of the disease, and another one is formed beyond it, which in turn gives way to still another. In such cases the originally affected tissue may remain as a small sequestrum in a comparatively large cavity. There is no good reason for believing that sequestra shut up and bathed in pus are ever dissolved thereby.

A section through a typical tuberculous focus includes an outer zone, a middle zone, and a central area. In the first are found engorgement of blood-vessels, proliferation of the cellular elements of the tissue, and some tuberculous follicles. The general color of this zone is red. The middle zone is that in which the tuberculous deposits are most numerous. This area is semi-transparent, and but slightly red in color. The interspaces of the tissue are occupied by a gelatinous mass, compared to frog-spawn. In the central zone there is an ulcerated condition, with breaking down of the trabeculæ, and often with the presence of small detached pieces of bone—sequestra.

With these general statements it may be worth while to repeat that, in diseases of bone, the general characteristics are dependent upon the specific character of the malady; the histological changes which take place are those common to certain well-understood processes. Thus in tuberculous osteitis, there is, first, hyperæmia; then the formation of granulation tissue, with condensation on the one hand, or solution and re-infection on the other.

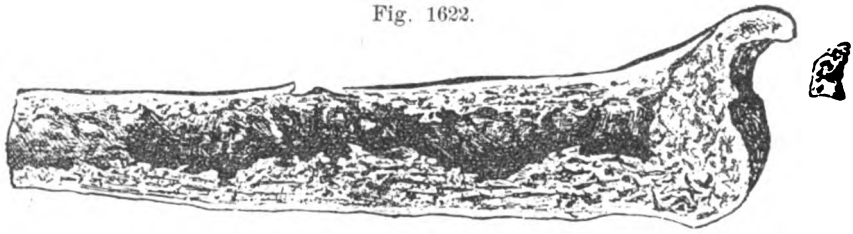
The seat of greatest activity is in the middle area, between that recently attacked and that which has already borne the onset. In this process the anatomical elements of the bone act in accordance with their physiological properties: osteoblasts contributing to the production of resistant tissue, and osteoclasts advancing the process of solution. The early death of any considerable portion of the bony tissue leaves this like a foreign body in the centre of a cavity, which fits it closely or loosely according to circumstances, and which in either case makes what Frank[1] has picturesquely called a "coffin for the sequestrum."

The processes of tuberculosis include caries as well as necrosis, and the cavities in the bone may contain a fine sandy material consisting of very small portions of dead bone-tissue, or nothing but a gelatinous or puriform fluid. As in all forms of osteitis, tuberculous osteitis may be strictly localized, or it may be scattered over a considerable space. It may be primary, or it may give rise to secondary metastatic infection of the bone, or even of remote organs. The results of tuberculous osteitis may be destruction of considerable portions of bone, spontaneous fractures due to weakening of the bones, collapse of their articular ends, infection of the joints, or burrowing of pus and the formation of abscess-cavities in the soft parts, as is seen in cases of psoas abscess caused by caries of the vertebræ. Tuberculous osteitis resembles

[1] Grundriss der Chirurgie. Stuttgart, 1893.

other forms of bone disease in occurring, as Ollier has pointed out, in the great majority of cases in early life, when the process of develop-

Fig. 1622.



Ossifluent Abscess (Tuberculous) due to Osteitis of Internal Malleolus. (Gangolphe.)

ment of bones is most active. Probably one-third of all diseases of the bones are found in children under ten years of age, while about one-half occur in persons under twenty years.

Fig. 1623.

Tuberculous Osteitis of Vertebræ. (Lannelongue.)

In connection with tuberculous disease of the bones, there is often present disease of the joints and of the surrounding tissues. After a certain length of time the tuberculous process in a bone causes progressive destruction of the overlying structures, until the disease extends to the surface. The communication may take place by means of narrow and tortuous sinuses, or by such destruction of tissue as causes the formation of large abscess-cavities outside of the bone. An illustration is seen in psoas abscess. In some cases the external manifestations are insignificant as compared with the extent of disease in the bone, as was seen in a case reported by Gangolphe, in which he amputated in the upper third of the leg, in a case of disease of the ankle-joint, because he found a depression in the tibia indicating a loss of substance. The wisdom of the operation was shown when a section was made of the tibia, which was found to be occupied by a very large medullary ossifluent abscess. See Fig. 1622.

The communication of tuberculous disease from bone to bone is sometimes particularly noticeable in the spinal column, where the bodies of a number of vertebræ may be affected either at or about the same time. A striking illustration of this is seen in a specimen of M. Lannelongue, shown in Fig. 1623.

Tuberculosis of the bones occurs most

frequently in the spinal column and in the long hollow bones, although it occurs also in the short and the flat bones, like those of the tarsus, carpus, pelvis, and cranium.

DIAGNOSIS OF TUBERCULOSIS OF THE BONES.—This is sometimes difficult, especially if we bear in mind the fact, mentioned earlier in this article, that absolute certainty of the presence of the tubercle bacillus of Koch can be secured only by discovering this bacillus in the products of the lesions, or by means of culture experiments. On the whole, it may be said that what is now called tuberculosis is pretty much what used to be called scrofula, and has the symptoms, long ago well known, of that disorder. The special peculiarity of tuberculosis is, that it is a disease which advances slowly and insidiously, with little or no suffering, with few or no constitutional symptoms, and consequently with little or no warning of what is taking place, until pain, deformity, and distention or discoloration of the skin attract attention to the disease at a point removed from that at which it is most active. In this, tuberculosis presents a striking contrast to other forms of osteitis, which are usually of an acute type. As stated above, there is a chronic form of osteomyelitis in which there is no such pain as occurs in the acute infectious variety; this affects the diaphysis of the bone, is accompanied by the formation of pus, and does not give rise to the formation of fistulous tracks or the production of fungous tissue. Of course the detection of staphylococci would settle the diagnosis.

Tumors of the bones, especially sarcomata, might possibly give rise to a suspicion of tuberculosis; but the whole history of tumors and their general appearance usually make them comparatively easy of recognition. When such tumors have undergone fatty degeneration and suppuration, there may be a question of diagnosis, as stated by Gangolphe. But, as he says, such cases are exceedingly rare. Gummata of the bones are usually situated on the diaphyses, and usually a history of syphilis can be elicited on careful inquiry. Hydatid cysts of the bones are exceedingly rare, but when they occur they present very much the symptoms of tuberculosis. The patients, however, give little evidence of constitutional disease even when the cysts are quite large, and an error of diagnosis may be avoided by considering the impression received on palpation, that the contents of the sac are very thin and watery. An exploratory puncture, with an examination of the contents, would settle the diagnosis. Ollier saw a case in which he found a hydatid cyst in the upper third of the forearm, in a young woman whom he had already treated for tuberculous arthritis of the knee.

In most cases of tuberculosis of the bones considerable progress has been made before the patient comes to the surgeon, who finds disorganization of the tissues already existing, although the evidences of disease may have but recently come to the surface so as to attract the attention of the patient. In such a case one may be consulted on account of pain attributed to rheumatism, which on examination is found to be caused by an abscess, and on further examination this abscess is found to be of a type called ossifluent. In other cases elevations of the skin first attract the patient's attention, in others its discoloration. In a case recently under the care of Dr. Willard in the Presbyterian Hos-

pital, a painless swelling below Poupart's ligament, in a colored woman, was found to be dependent upon caries of the lumbar portion of the spinal column, and to be the lower part of an abscess cavity which was easily probed from the groin along the inner side of the ilium, to a point above its crest near the spine, where a counter-opening was made for the passage of a large drainage-tube. Such a case illustrates, as every surgeon knows, the great extent to which the lesions of tuberculous osteitis may go before surgical advice is taken. In these cases the progress of the disease is very slow, but, on the other hand, it may be very rapid; as was seen in another case, under the care of Dr. O. H. Allis in the same hospital, where a man of seemingly excellent health sustained a violent contusion of the patella, followed by rapid disintegration and the formation of ossifluent sinuses, necessitating the removal of the entire bone. This case precisely parallels the experimental tuberculosis produced by Schüller by injuring the bone and inoculating the subject with tuberculous matter.

TREATMENT OF TUBERCULOSIS OF THE BONES.—This is partly constitutional and partly local. Slow as is the course of the disease in many cases, and slight as are the accompanying constitutional manifestations, it is desirable to treat it by those means which are ordinarily useful in the treatment of tuberculosis elsewhere. This includes the use of cod-liver oil, the hypophosphites, iodoform, creasote, guaiacol, and similar agents, continued for a long time, and with perseverance, as in other forms of tuberculosis.

A word should be said in regard to the treatment of tuberculosis of the bones by the tuberculin of Koch. This may now be said to be abandoned. The enthusiasm with which it was at first received has entirely disappeared, and tuberculin, if used at all, must be regarded as a purely experimental agent and not one of demonstrated value.

The *local treatment* of tuberculosis consists usually in the fixation of joints, the prevention of motion, cauterization, the injection of astringent materials, or the removal of the diseased tissue by the knife or by suitable dull or partly sharp instruments. In regard to the former methods, little that is novel has appeared since the previous volumes of this Encyclopædia were issued. A good deal of attention has been attracted to the plan of injecting curative, irritating, or hardening fluids into the diseased tissue, in cases of joint tuberculosis. Of the curative agents, iodoform is probably the most striking example. This has been used dissolved in ether, or partly dissolved and partly suspended in oil or glycerin. Carbolic acid, nitrate of silver, and tincture of iodine, as also perchloride of iron and chloride of zinc, have likewise been employed. There can be no doubt that good results are obtained by any material which will convert a tuberculous focus into a mass of dead but sterilized tissue. A mode of treatment of surgical tuberculosis strongly recommended by Max Schüller consists in the combination of medical treatment with surgical, as suggested above. He administers to tuberculous patients benzoate of sodium, creasote, guaiacol, and cod-liver oil, in a way which has much to recommend it theoretically. Personally I have confidence in the use of creasote and guaiacol, as constitutional remedies in the treatment of surgical tuberculosis, as well as of tuberculosis of the lungs.

An important question in regard to the treatment of bone tuberculosis is that of the time at which to begin operative interference. In regard to this, opinions differ. Collections of tuberculous material need not always be operated on as soon as found. If such collections are limited in area, and can be thoroughly removed, there is no reason to doubt the propriety of treating them actively and by operation; but in some cases too early interference converts a comparatively innocent lesion into one that is very inconvenient to manage. Probably in the great majority of cases which come to a surgeon's notice, the disease is in such a stage that there can be no question about the desirability of treating it by operation. This operation may be puncture followed by injection, incision, scraping, tunnelling, resection, exsection, or amputation. To describe the cases to which each of these methods is applicable, would require more space than can here be spared, in view of the fact that these procedures are described in every work on surgery.

In the neighborhood of joints, the treatment resolves itself frequently into a question of excision (arthrectomy) or resection, or in many cases amputation. The last is a method of last resort. The experience of the school at Lyons, of which Ollier is the great head, has relegated amputation to a very subordinate place in the treatment of tuberculous diseases of the extremities. Of the two former modes, resection of the bone is not only simpler, but on the whole more practical. In the case of children it is often desirable to save, if possible, the developmental cartilage. In the case of adults, the ease with which one can go beyond the area of infection, and the fact that the period for increase in length of the bones has passed, combine to make it more desirable to practise what are called typical resections, in contrast to atypical resections or arthrectomies.

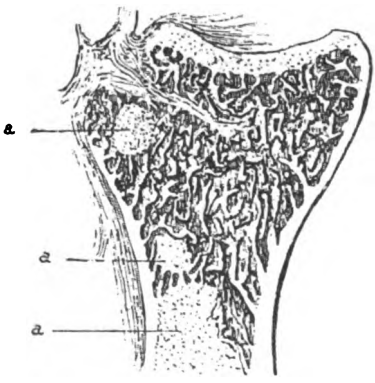
The question sometimes arises, what shall be done in the case of a person affected with tuberculosis of the lungs who presents serious symptoms of bone or joint tuberculosis, or of one with tuberculous bone disease with active febrile development? This question has to be decided separately for each case, weighing the advantages of operative treatment with the risks of an unfortunate result. The power of recuperation in tuberculous patients is sufficient to justify operation in some cases. A knee, for example, which keeps a man absolutely helpless may be wisely operated upon. In such cases, however, the simplest operation is always to be preferred; and the simplest is amputation.

In the treatment of tuberculous inflammation of the hip-joint, which by many orthopædic surgeons is regarded as the only form of chronic hip-joint disease, and which is usually the result of tuberculous osteitis of the femur, rest and fixation sometimes accomplish a complete cure. Gibney says that they effect a cure in a large proportion of cases, if used early. If suppuration occurs, Gibney aspirates small abscesses, but does not inject them, from three to six aspirations being usually required. If these fail, the abscesses may be opened, curetted, dried, packed with iodoform gauze, and covered with an antiseptic dressing. Such treatment often results in apparent cure; but this may be followed by relapses.

Leprosy of the Bones.

In leprosy, as might be expected, the bones are frequently attacked. Of course they are always attacked in cases of deforming leprosy, in which fingers, for example, are lost. There are two forms of disease of the bones present in leprosy, one of which is of a rapidly destructive character, accompanied by caries and necrosis, and rapid loss of substance; the other is a species of atrophic osteitis. In both conditions, examination reveals the presence of the bacteria of leprosy in the bones. Fig. 1624, taken by Gangolphe from Sawtschenko, shows the appearance of a phalanx invaded by several colonies of lepra bacilli. In this disease, as in most diseases of the bones, the point of invasion is usually the epiphysis or the juxta-epiphyseal region. Active resorption or disintegration distinguishes leprosy of the bones, in a manner analogous to what is seen in the soft parts. In some cases osteophytes have been discovered, which are supposed to have been produced by stimulation of the osteoblasts by the presence of lepra bacilli. In the Trinidad Asylum for Lepers, Rake finds that operation wounds in general heal kindly, amputation wounds included. He reports 630 operations of sequestrotomy with good results. In certain cases he relieved the pain of leprosy, affecting the bones, by very deep incisions. In the foot, these sometimes were carried through and through the part. Active interference seems, therefore, to be not only justifiable but also successful in cases of disease of the bones in leprosy.

Fig. 1624.



Section of First Phalanx of Thumb of a Leper. (Sawtschenko.) *a*, *a*, *a*, Nodules of leprosy.

Syphilis of the Bones.

The subject of syphilis of the bones is as extensive and as interesting as that of tuberculosis of the bones. As part of a constitutional disease, it is discussed in treatises on this disorder, and also in all treatises especially devoted to bone diseases. It is a manifestation of what is commonly called the tertiary stage of syphilis, although, as is well known, severe osteocopic pains, usually felt in the shaft of the long hollow bones, and especially in the tibia, occur sometimes within six or eight weeks after the appearance of the initial lesion. At this stage there is at times an obscure form of irritation of the periosteum or of the bone immediately below it, giving rise to pains of more or less severe character which resemble rheumatic pains rather than the pains of osteitis due to a specific virus. They intermit by day, and are often relieved by pressure, instead of being aggravated by it. They are not accompanied by heat or swelling, and they may shift from one part to another. Such pains are not peculiar to syphilis, for they occur in other disorders of the bones; but they are so frequently found in

syphilis, and so infrequently in other disorders of the bones, that their presence leads properly to the suspicion that syphilis is present.

True syphilis of the bones, with distinct lesions, is, as stated above, a manifestation of the later stages of the disease. The lesion characteristic of this form of osteitis is the gumma. Such a lesion, forming under the periosteum, its most common seat, gives rise to an inflammation in which the neighboring tissue is involved. There is usually a viscid, serous effusion between the bone and the periosteum, which elevates the latter in a half-fusiform swelling, highest at or near the

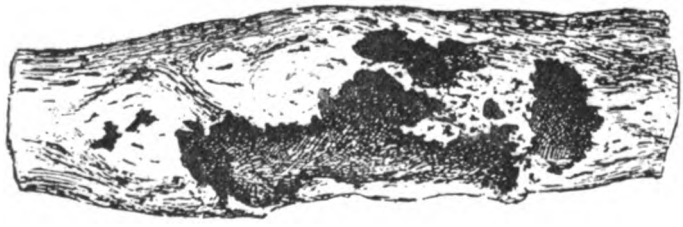
Fig. 1625.

Gummatous (Syphilitic) Osteomyelitis of Tibia. Partial ossification of medulla; rarefaction of new bone tissue. (Gangolphe.)

middle, and gradually subsiding toward the ends. This is firmly attached to the bone, of course, while over it the skin is at first movable. It is usually tense, but sometimes yields to pressure. This is what is called a node. Such a node may be absorbed and disappear, under appropriate treatment, or it may break down and ulcerate, giving rise to a syphilitic ulcer.

In the substance of the bone, gummata give rise to an irritation in which a large part of the bone or the whole bone may be affected, together with the surrounding tissues. The characteristic of syphilitic osteitis is that the medullary cavity is often enlarged, and the surrounding bone eburnated or porous, with a total absence of true suppuration or necrosis; a sequestrum may be said almost never to be formed. On section, a bone showing the characteristic lesions of syphilis presents an eburnated cortical layer, a rarefied or excavated medullary region, with erosions of the walls due to caries—molecular disintegration. (See Fig.

Fig. 1626.



Gummatous (Syphilitic) Osteomyelitis of Tibia. Extensive erosion of compact layer.

1625 and Fig. 1626.) This is the process usually found in the long bones. In flat bones perforations occur, surrounded often by eburnation, due to condensing osteitis. In the skull, these perforations occur most frequently in the frontal bone; and it is a curious fact that the vitreous table resists for a long time the tendency to perforation. Similar perforations take place in the scapula.

In the fingers a form of inflammation occurs which produces a swelling like that of tuberculosis, called spina ventosa.

PATHOLOGY.—The pathology of syphilis of the bones is indicated by what has already been said in describing its lesions. It differs from diseases with which it might be confounded in diagnosis, in that it is more painful than sarcoma or tuberculosis of the bones, and of much slower development than acute infectious osteomyelitis. The chronic form of osteomyelitis might perhaps be confounded with syphilitic disease, but a careful study of the history of the case, taken with the multiplicity of lesions common in syphilitic disease of the bones and uncommon in osteomyelitis, and the absence of implication of near superficial lymphatic glands in the case of syphilitic osteitis, would make it unlikely that these two should be mistaken one for the other.

TREATMENT.—The treatment of syphilis of the bones is the treatment of all forms of tertiary syphilis. The various preparations of iodine or of mercury, or both, depending upon circumstances which we need not here consider, and which belong to the general state of the patient rather than to any particular manifestation of the disease which he may present, are the remedies which are most appropriate to the cure of syphilitic disease of the bones. The iodides appear to exercise an especially favorable influence in causing the resorption of gummata. Mercury, in this stage of the disease, is to be used for its tonic effect. Happily, syphilis of the bones is ordinarily quite amenable to treatment, and responds promptly to appropriate medication.

Fig. 1627.

Tænia Echinococcus from Dog. (Payne.) *a*, Tænia, mature (× 10); *b*, ovum (× 250).

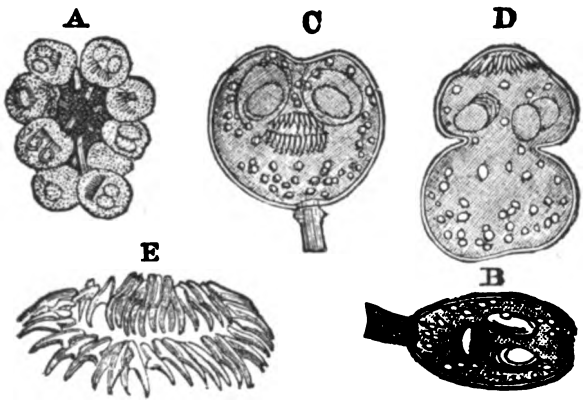
HYDATID DISEASE OF THE BONES.

One of the rarest forms of disease of the bones is that caused by the presence of the cysts of the larva of the tænia echinococcus. This parasite is usually derived from the intestine of the dog, which is the natural habitat of the fully developed tænia. The whole tænia is only one-quarter of an inch long, and consists of but four segments (Fig. 1627).

The rings or proglottides of this tænia when matured are evacuated with the excrement; the ova are then set free by disintegration of the surrounding tissue of the ring, and, on being swallowed, their own surrounding membrane is dissolved in the gastric juices of their new host, so that the embryos (pro-scolices) are set free. Finding their way through the wall of the intestine, and into the blood current, they may be conveyed to any part of the body. At the point of arrest, the embryo surrounds itself with a membranous sac, which is filled with a liquid; the whole constituting what is known as a hydatid cyst. The original cyst is sometimes called the mother-cyst, and may have connected with it a number of smaller ones, called secondary or "daughter" cysts. In these are developed immature tæniæ (scolices) which need only liberation and transfer to a suitable soil, to develop into the perfect tænia echinococcus. In whatever tissue a hydatid, single or multiple, is situated, it is surrounded by a wall of connective tissue, formed as result of the irritation of the growing parasite. Within this is the true wall of the cyst, and within this the liquid contents and the scoli-

ces, with various substances in solution or suspension. The inner layer of the cyst produces, by a process of budding, the scolices or echinococcus-heads. These may be developed to an enormous number, or they may be comparatively few. (See Fig. 1628.) The scolices are from one-sixtieth to one hundredth of an inch in length, and are armed with a row of hooks, the shape of which is absolutely characteristic. The head of the scolex is usually seen invaginated within the body, so that the hooklets look like internal organs. In some cases the mother-cyst contains a number of so-called daughter-cysts; in other cases the mother-cyst produces on its exterior daughter-cysts, which invade the tissues outside of the original cyst. The more a hydatid tends to be multiple, the less is it likely to produce scolices, and the more likely is it to grow as a collection of barren cysts and vesicles.

Fig. 1628.



Human Echinococci. (Payne.) A, Group of echinococci adhering to germinal membrane by their pedicles (× 40); B, echinococcus with head invaginated (× 107); C, same compressed, showing suckers and hooklets; D, echinococcus with head protruded; E, crown of hooks—two circles (× 350).

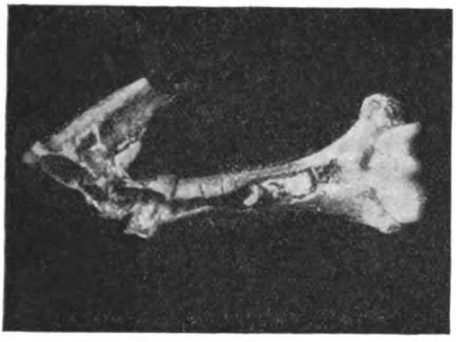
The tendency of hydatid cysts is always to increase, although slowly, and to produce damage chiefly by their mechanical influence. The most common seat of hydatids is the liver, but any other organ or tissue of the body may be invaded.

When hydatids occupy the bones, they are usually unsuspected and undiscovered until they have lasted a long time; because they are of slow development, do not produce deformity, and do not give rise to pain. Their discovery is frequently the result of an accident, such as a so-called spontaneous fracture; after which the diagnosis may be made or not according as the observer is acute and well informed.

The location of hydatids of the bones is always in their interior, in the spongy tissue, and usually at the end of the diaphysis, in the juxta-epiphyseal region of the long bones. The bones most usually affected are the tibia, near its head; the femur, near its head; the ilium and the vertebræ. A bone containing hydatids usually presents no sign externally until its walls have been so thinned by the growth of the parasite that they give way at some point through which the cyst protrudes or bursts, or at which the bone breaks. Inside the bone, the spongy tissue is destroyed in two ways: first, by mechanical pressure, causing resorption; second, by necrosis, caused by ischæmia produced by pressure of the cyst upon the blood-vessels. In the first case the cavity in the bone is occupied wholly by hydatid cysts; in the second case there is also a collection of puriform fluid and of small, or even large, sequestra. The puriform fluid is sometimes of a character aptly compared to pea-soup. The cavity in a bone caused by hydatids is usually sacculated, or with anfractuosities. The progress of hydatids in a

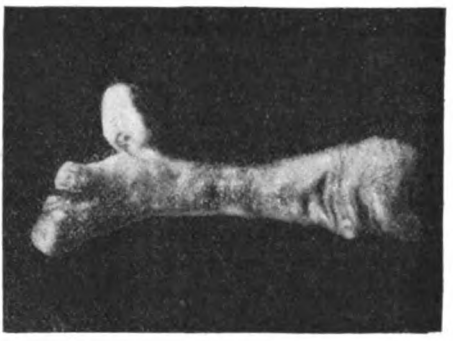
bone may be in either direction: first, onward in the bone itself; second, toward a neighboring joint. The annexed illustrations, Figs. 1629–1634, taken from an able paper by Mr. J. H. Targett,[1] show the appearance presented in various cases of hydatids of the bones. If the progress is toward a joint, the hydatid does not invade the cartilage,

Fig. 1629.



Human Humerus, Fractured.

Fig. 1630.



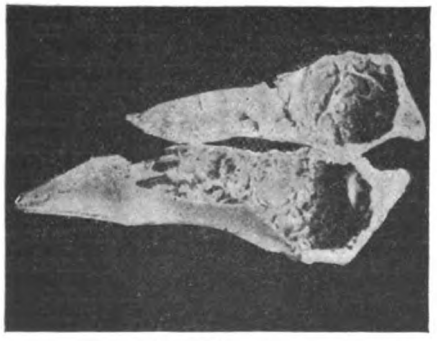
Cyst Removed from Humerus of an Ox.

but sets it loose by destroying the bone with which it is connected, and crosses over to an adjacent bone, passing by its cartilage. The destruction of a joint, such as the coxo-femoral, may result in a dislocation of the head of the femur, through disintegration of the cotyloid cavity, into the pelvis.

Connected with a hydatid of the bones there may be invasion of the surrounding tissue, or, by rupture of the cyst, infiltration with the formation of sinuses, or of abscesses precisely like the ossifluent abscesses found in other disorders of bones.

When hydatids approach the surface—which they do very slowly and without exciting constitutional symptoms—they may be mistaken

Fig. 1631.



Ischium of an Ox.

Fig. 1632.

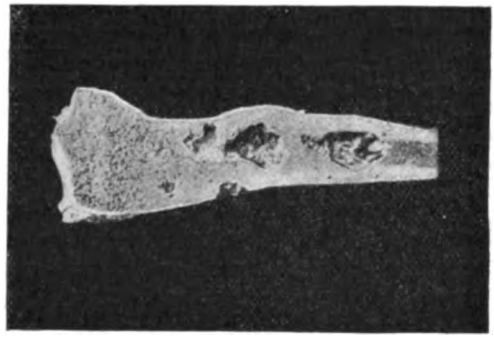
Cyst in Human Tibia.

for cold abscesses. If, under these circumstances the surgeon opens them and puts their interior in communication with the air, they immediately change their character, and produce violent constitutional disturbance, which may end in death.

[1] Guy's Hospital Reports, vol. l., 1894.

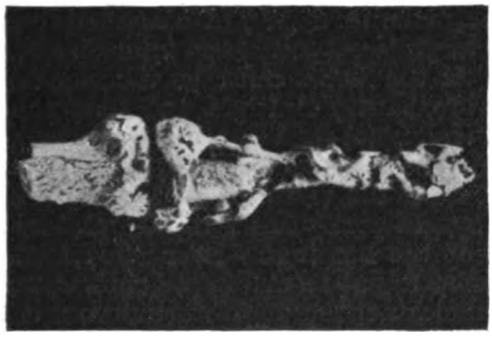
Hydatids of bone probably occur much oftener than statistics would indicate, because they usually receive but passing notice in works on surgery, and are not even mentioned in some well-known works on pathology. They are chiefly to be distinguished from cancer, syphilis, sarcoma, and tuberculosis. In cancer there is usually cachexia and often multiple manifestations; cancer of the bones is rarely found without other unmistakable manifestations of cancer. In syphilis of the bones there is usually a distinct history, an obvious involvement of the cortical portion of the bones, with, in most cases, pain (osteocopic pains) occurring in the course of the development of the disorder. In sarcoma there is usually a much more rapid development, and a very distinct tumefaction of the bone, with an absence of fluctuation. These characteristics make the diagnosis, if once the idea of hydatid is entertained, comparatively easy. Certainty is assured by the examination of the contents of the cysts, which, except when pus is formed, are of a transparent character, often almost colorless, sometimes straw color, and often containing hooklets which are unmistakable when seen under the microscope. A spontaneous fracture of a bone occurring in an apparently healthy person, should always lead to a suspicion that a hydatid may be present.

Fig. 1633.



Human Tibia.

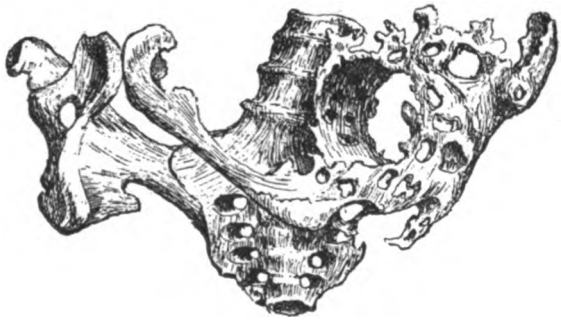
Fig. 1634.



Human Femur, Tibia, and Fibula.

DIAGNOSIS. — The most likely source of error in regard to the diagnosis of hydatids of the bones is tuberculosis. The cold abscesses of this disease may present a close resemblance to the fluctuating swellings caused by the formation of a hydatid cyst in the soft parts connected with the parent cyst in a bone; and it has even happened to Ollier to see a case in which a hydatid cyst was found in the same patient on whom he had formerly operated for tuberculous disease of a

Fig. 1635.



Large Hydatid of Pelvis. (Gangolphe.)

joint. Such a case as is seen in Fig. 1635, where the pelvis was extensively involved, might prove troublesome in diagnosis. But ordinarily the general history of the case will help in differentiation.

In doubtful cases one important thing must be remembered, namely, that the thought of rare diseases should be in the mind of the surgeon whenever diagnosis is not simple. More cases would probably be recognized if this point were not overlooked, and our knowledge of the subject would undoubtedly be greater. The only sure test in doubtful cases is to make a puncture—under the strictest aseptic conditions—or even an exploratory incision, and to examine the contents of the cyst. Of course if this contains the characteristic liquid contents of hydatids and they are surrounded by the characteristic wall, the absence of hooklets will not militate against the diagnosis; while the presence of hooklets is absolutely conclusive.

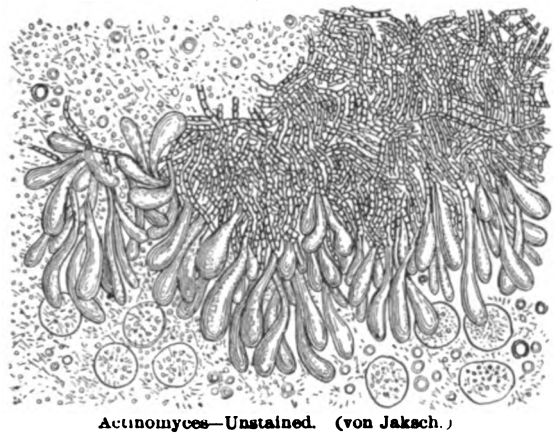
TREATMENT.—The treatment of hydatids of the bones must be of the most radical character. Temporizing or hesitation may be fatal to the patient. It is beyond doubt that many of the deaths reported from this disorder have been due to improperly conducted incisions, which were followed by access of septic material to the cavity of the sac, with rapid development of generalized septic infection of the patient. Whenever an exploratory incision is made in a case of suspected hydatid of a bone, the operator must be prepared to proceed immediately to a radical operation. Hydatids of the bones must be thoroughly eradicated, remembering that they are usually multiple, and that the removal of a single cyst, or even several, is not sufficient, but that every particle of the diseased structure must be removed or destroyed. The exact form of eradication depends upon the situation of the morbid growth. The flat bones must be opened freely and scraped out, and perhaps treated with an application of the hot iron. Even the spinal column may be operated upon, in order to put an end to pressure upon the cord. After any operation of this kind, thorough washing out of the cavity and drainage with large drainage-tubes must be employed. In certain cases, as after spontaneous fractures of the long bones, the necessity for amputation may arise. Experience indicates that little reliance can be placed upon resection of the bones, and when joints are involved, or large parts of the bones of the limbs, it is usually necessary to amputate at some distance from the seat of disease.

ACTINOMYCOSIS OF THE BONES.

The subject of actinomycosis of the bones is treated of very briefly in Vol. III. of this Encyclopædia, and something may be added to what is there stated in regard to the manifestations of this very rare disorder. It is almost unknown except in Germany and in the northern part of Europe, although von Jaksch says that it is a disease of very wide distribution, and that it is probably the cause of what is known as angina Ludovici. The first accurate description of actinomycosis, as a parasitic disease in animals, was given by Bollinger, and Ponfick first gave a scientific description of its occurrence in man, although he classed with this disorder two cases reported by Israel;

while, with the knowledge of these, Langenbeck concluded that a case which he had observed thirty years before at Kiel was of the same character. In recent years numerous publications on the subject have appeared, and the disease is now fairly well understood.

Fig. 1636



Actinomyces—Unstained. (von Jaksch.)

It is a curious fact that actinomycosis in man does not present manifestations like those seen in neat cattle. In oxen, the disease is known as "lumpy-jaw," because it is marked by swelling of the lower jaw-bone. In man, no enlargement of the bones occurs in actinomycosis, which has been observed in the jaw-bone, the vertebræ, the ribs, the clavicle, and the pelvis.

The parasite is a peculiar fungus, consisting of a sort of stalk, with club-shaped, radiating buds. Its general appearance is seen in Fig. 1636.

The progress of the disease is always from the soft parts to the bones. In the former there is a sort of abscess cavity, in appearance not unlike the ordinary ossifluent abscess, which on reaching the periosteum destroys this, and proceeds to attack the bone, which it invades by a process of erosion and caries. An illustration of the action of actinomycosis upon the bodies of the vertebræ is seen in Fig. 1637. In the case here illustrated, the bones were saturated with pus, so that it could be squeezed out of them as if from a sponge. Actinomycosis may successively invade one part after another of a bone, and pass from one bone to another through a joint. It is a characteristic of this disorder that its progress does not excite the reaction of irritation. Nowhere does the bone oppose its progress by the formation of a wall of inflammatory new tissue; on the contrary, the bone shows progressive rarefaction and caries, but never sclerosis or the formation of osteophytes.

Fig. 1637.

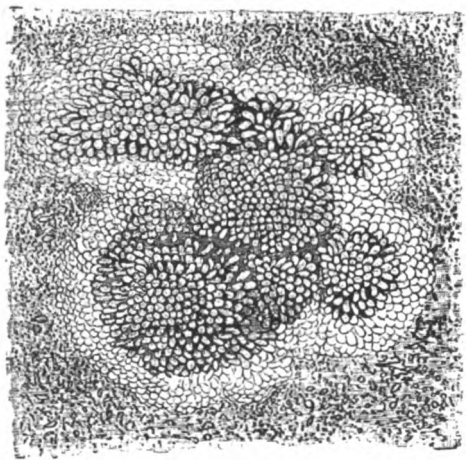
Actinomycosis of Vertebræ. (Gangolphe.)

The lesion of actinomycosis is a species of abscess or cyst, containing usually a seropurulent fluid, and bearing upon its wall, or containing in its cavity, certain granules of a yellowish color looking something like mustard seeds. These consist of an aggregation of small spherical masses, made up of pear-shaped agglomerations arranged radially about a centre. The general appearance of

such a granule under a low power of the microscope is seen in Fig. 1638.

To examine such a granule, it is sometimes necessary only to press it out under a cover-glass, while at times the surrounding viscid fluid must be dissolved with a little liquor potassæ. The contents of the actinomycosis cyst or cavity are sometimes viscid and serous, sometimes sero-purulent, and sometimes exclusively purulent. In the latter case it has been found that the detritus shows evidence of mixed infection, and the presence of staphylococci and streptococci of different varieties.

Fig. 1638.



Actinomycosis Granule. (von Jaksch.)

The usual mode of entrance of actinomycosis is by way of an injury within the mouth, caused sometimes by rough teeth, or, in cattle, by the lacerations produced by hard and sharp-edged food. It is stated that actinomycosis has been communicated from an animal to man, as reported by Hartmann and by one or two other observers cited by Gangolphe. Gangolphe failed in attempts to inoculate animals with actinomycosis, using the products of the lesions for the inoculation.

DIAGNOSIS.—The abscesses connected with actinomycosis resemble in many respects those of tuberculosis, being of an indolent character, of slow development, and unmarked by signs of constitutional reaction. In this respect they are not unlike the forms of hydatid of the bones in which the soft parts are invaded. The diagnosis is likely to rest upon the history of the case and the presence of some injury connected with the mouth, together with the appearances found in the sac when this comes to be opened.

PROGNOSIS.—The prognosis of actinomycosis varies according to the situation of the lesions. The tendency of the disease to progress is decided, but this tendency can be overcome by means of radical operations.

TREATMENT.—The treatment of actinomycosis is very much the same as that of hydatids, namely, free removal of all the diseased tissue. This must be followed up in all its anfractuosities, and the eradication practised must be of the most thorough sort. This may require the removal of a considerable portion of the soft tissues or of the bone, and should be followed up, in many cases, by an application of caustic liquids, such as a solution of chloride of zinc, or even by the application of the hot iron. The latter, besides being a most potent disinfectant, serves also to excite an irritation of the surrounding bone, which may cause the formation of an inflammatory barrier of new tissue against

further infection, and may provoke reparative action to supply the tissue which has alredy been sacrificed.

Disease of the Bones due to Disease of the Lung.

It is a curious fact that diseases of the lungs are sometimes followed by a peculiar disease of the bones. Attention was first called formally to this by Marie, in 1890, who described a peculiar kind of deformity following diseases of the lung or pleura, accompanied by the production of pus. The characteristic of this disease is a singular enlargement of the bones, especially in the extremities. In many cases the appearance of a patient with this disorder is quite like that of patients suffering with acromegaly. Marie calls this disease "*ostéo-arthropathie hypertrophiante pneumique.*" The pathology of the disease is entirely unknown, and its treatment consists in that appropriate to the conditions which give rise to it.

Albuminous Osteo-Periostitis.

This form of disease of the bones was described in 1874 by Poncet and Ollier as a distinct affection; but observations made by many different surgeons since then indicate unmistakably that it does not deserve this distinction. Its lesions are not new or peculiar; they consist principally in the pouring out, under the periosteum or near it in a bone, of a peculiar, viscid exudate, like synovial fluid, albuminous in character and containing a comparatively small quantity of phosphates. This description of albuminous periostitis fits perfectly well conditions in which the exciting causes are very unlike. Such effusions are seen, for example, after accidental traumatisms or amputations, and in the course of infectious or tuberculous osteo-myelitis. In many cases it has been found that the fluid has contained staphylococci. This form of effusion has also been found in traumatisms of the soft parts, the bone being entirely uninjured. In various disorders and injuries of the bones, the presence of an albuminous fluid is of some consequence as indicating a comparatively benign condition; but it is purely a concomitant and not an independent disease.

INJURIES OF JOINTS.

BY

EDMUND ANDREWS, M.D., LL.D.,

PROFESSOR OF CLINICAL SURGERY IN THE CHICAGO MEDICAL COLLEGE; SURGEON-IN-CHIEF OF MERCY HOSPITAL, CHICAGO.

DISLOCATIONS.

THE treatment of dislocations has in recent years been modified by the introduction of bolder operative measures. The weight of authority now is on the side of arthrotomy, or free section of the soft tissues, in all cases where from any cause the reduction cannot otherwise be accomplished. Under antiseptic management the knee and other large joint cavities are now cut down upon, subperiosteal detachment of muscles and ligaments effected, and various plastic and reparative operations done without fear of injury to joint function. Arthrotomy, as a conservative substitute for excision in old dislocations, is rapidly gaining ground. In the case of congenital dislocations of the hip the special operations of Lorenz and Hoffa seem destined to supplant all other forms of treatment, effecting, as they do, nearly complete cure.

It is only within half a decade that much attention has been directed to the subject of arthrotomy, although theoretically the possibility of curing old dislocations by such means has been recognized since the advent of antiseptic surgery. The chief credit for the perfection of arthrotomy as opposed to arthrectomy must be given to the German surgeons, whose work has been the basis of the modern practice of English and American operators.

SPECIAL DISLOCATIONS.

VERTEBRÆ.—Luxation of the cervical vertebræ can undoubtedly occur without fracture. In the dorsal and lumbar spine this is probably impossible. Walton reports five cases with only one death, and one followed by permanent paralysis. In the remainder there was slight loss of power of rotation. A case is reported by Feranchomme in which the sixth and seventh cervical vertebræ were displaced laterally, and the atlas forward, with paraplegia. Autopsy showed also hemorrhage in the spinal canal. La Place, in an old dislocation of the fourth cervical vertebra, recently performed a successful arthrotomy, cutting the soft parts down to the laminæ and forcing the displaced bone into position. This, the first case of its kind, was followed by recovery. No disability remained after three months.

Great difficulty will be experienced in determining the presence of fracture in these cases. Probably more of them should be cut down upon, as in fracture the operation is even more strongly indicated than in simple dislocation.

RIBS.—At least one case of dislocation of a rib from its corresponding vertebra has been reported (Quint). This confirms the statement of earlier writers. Late authors have doubted the existence of this displacement except by fracture of the costal neck. In Quint's case an autopsy was made and the diagnosis verified. The first rib was separated by the passage of a wagon-wheel across the body. Costo-chondral dislocations are not always reducible. Bradley reports a case of displacement of five ribs backward from their cartilages in which replacement could not be effected. Although dyspnœa existed at first, complete recovery followed, though with deformity. Other similar cases have recently been published (Stoner, Stimson). A free incision of the skin and muscle, care being taken to avoid the pleura, would give an opportunity to grasp the rib by forceps, but no such operation has as yet been reported.

STERNUM.—The injuries caused by railway accidents include not infrequently displacements of the bones of the sternum. The accident is far more common than formerly. In several cases seen by myself, the cause has been the same, viz., crushing of the chest between moving cars in the occupation of switching or coupling them together. Usually such cases have a fatal ending from other injuries. In one case of backward dislocation of the manubrium I was unable to effect reduction, and as the patient declined operative interference the deformity remained. There was, however, no dyspnœa or apparent disability after a few weeks.

CLAVICLE.—The treatment of dislocation of the sternal end is often disappointing. The deformity which remains has recently been treated by periarticular injections of alcohol. Stimson reports success in restoring normal position by this measure. Double dislocation of the sternal ends was successfully treated by Carraher, pressure being applied by a figure-of-eight bandage crossing over the heads of the bones. The difficulty in these cases is not the reduction, but the retaining in position.

SHOULDER.—Ory reports a case of dislocation of the shoulder from muscular action in striking out with the fist. This accident has also occurred in swimming. Sir J. Lister reports two cases of double dislocation, one of which was caused by lifting a man from the water by the hands. A dislocation of the shoulder has recently been reported in a child two years old, said to have been the youngest patient in whom this injury has been noted. Autopsies made by Berthat would seem to show that a portion of the tuberosity of the humerus is commonly torn off in dislocations. Stimson found in an irreducible dislocation of the shoulder that the tendon of the subscapularis crossed the head of the bone. After this had been divided, reduction was easy.

Arthrotomy is much to be preferred to manipulation or excision in

old dislocations of the shoulder. Rupture of the axillary artery is a danger not to be overlooked in efforts at reduction by manipulation. Forty-four cases of this accident, with a large percentage of fatal endings, had been reported up to 1885.[1] In the treatment of this accident ligature of the subclavian has given the best result:—

In 7 cases	with double axillary ligature	.....	all died.
" 14 "	" subclavian "	.....	9 "
" 19 "	without operation	.....	13 "
" 4 "	with amputation at shoulder	.....	3 "

Körte, of Berlin, claims that in many cases the rupture of the artery occurred at the time of dislocation, the bleeding being prevented by pressure of the head of the bone until relieved by reduction, but this view does not seem to be supported by the history of most of the cases. The application of pressure should always be tried, and will cure a small portion of these cases. If it fail and the resulting traumatic aneurism be large, either ligature of the subclavian or amputation will give better results than cutting down and placing a double ligature on the axillary.

Arthrotomy is preferable to excision as giving a more useful limb and being an operation of less severity. Sir Joseph Lister makes an incision from the coracoid process a little outward and downward. All the muscles are detached from the tuberosity of the humerus by a chisel or periosteotome, and reduction is then usually easy. If not, then the head of the humerus is turned out of the wound and the rotators detached, which allows the bone to go into place. Four cases treated by this method were all successful. Robson, McLaren, Stimson, and Morton report numerous successful cases of arthrotomy of the shoulder to assist reduction. The last writer makes an incision through the deltoid instead of that employed by Lister.

ELBOW.—After dislocations of the elbow extensive deposits of bone sometimes occur behind the external condyle, causing limitation of motion, as in fracture. Several cases have recently been reported of this result without fracture having been present. The pathology of the obscure injury known as subluxation of the head of the radius has been cleared up by a careful analysis of 100 cases made by Van Arsdale. In many of these cases there is really a fracture of the neck of the bone.

The only case on record of inward dislocation of the ulna at its upper end is reported by Loison. The bone remained luxated, and there was some limitation of motion.

Arthrotomy for old dislocation is to be recommended in this as in other joints. Ssokolow reports four successful cases and advises against excision. Ollier reports a case of successful arthrotomy after 54 days. He declares that "the section of all structures holding the joint in abnormal relation is preferable to excision."

The incision should be in the posterior line. The chisel may be used to separate the attachment of the triceps. After the "toilet" of the joint this may be replaced by nailing or wiring. In some cases a temporary suture of the joint has been used to prevent reluxation. Maydl has reported six cases, and Nicoladoni nine cases of this operation, all successful.

[1] Annals of Surgery, November, 1885.

THUMB.—Great difficulty is often experienced in reducing dislocations of the proximal phalanx. An important step in the procedure is rotation in both directions, in order to clear the bone from the two heads of the short flexors. Subcutaneous section of the glenoid ligament, or open dissection, should always be resorted to if necessary. Guermonprez makes prolonged traction followed by rotation. Palmer advises the making of a small buttonhole in the palmar surface, and the introduction of a lever to pry the head into position. I am disposed to think highly of this expedient.

HIP.—Recent autopsies seem to show that in many cases the pyriformis, obturator internus, and gemelli muscles are torn in dislocation of the hip. The acetabulum is commonly fractured at its margin, and fragments of the head of the femur are often broken off. Thorndyke reports a case of backward dislocation reduced after eleven months by manipulation alone. A case of compound dislocation in a girl of 8 years is reported at the Boston Children's Hospital. Infection and suppuration were not avoided, but recovery finally was secured with bony anchylosis. Parkes reduced two cases of ancient dislocation of the hip by cutting the muscles very widely and using manipulation. Chiene, Nélaton, Volkmann, Quénu, Severeano, Sydney Jones, Paci, Nicoladoni, Marguary, Vecelli (twice), Villeneuve, Hughes, Gerster, Harris, and Robson also report such cases. Kinn has collected reports of 19 cases of arthrotomy of the hip for old dislocation, with 3 deaths. Since 1890 the operation has received much attention. Nélaton and the early operators favored an incision over the displaced head of the femur, that is, posterior to the trochanter in dorsal dislocations. While this readily uncovers the head itself, it renders it difficult to get access to the acetabulum and ligaments. There is still a muscular and ligamentous resistance which prevents reduction, and which requires free sub-periosteal section for its removal. A long, free, anterior incision will usually lead more directly to the acetabulum. This must be carried along the great trochanter far enough to allow free dissection from it of all the shortened and resisting muscles and their tendons. The acetabulum and capsule are, after fourteen days, liable to be filled with new deposit. Volkmann has shown by experiments on dogs, that, up to twelve days, this is soft granulation tissue easily pressed or wiped out by the returning head. After this time it may be found firm. An essential part of the operation consists in clearing out the acetabulum with a sharp spoon, prior to reducing the bone.

Excellent functional results follow this operation when technically well done and not complicated by septic accidents.

The very important operation of Lorenz and Hoffa for congenital dislocation of the hip marks an era in the treatment of that deformity. It is appropriately discussed in the section on orthopædic surgery.

KNEE.—Considerable interest has been shown of late in dislocations of the semilunar cartilages, cases having been reported by Craft, Allingham, Davies-Colley, and Annandale.

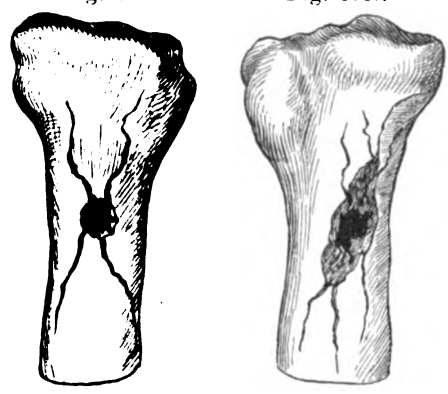
Annandale operates by a circular incision, exposing the joint in front and laterally, and then drawing out and securing the cartilage by sutures.

Congenital dislocations of the knee are reported by Joachimsthal, and

at a meeting of the New York Academy of Medicine six cases were referred to, of which three were double.

PATELLA.—If necessary in the reduction of old dislocations of the patella, the vastus externus may be cut. In order to retain the bone in position Lucas-Championnière cut a groove with a chisel, and placed the bone in the groove. Roux sewed the capsule to assist in holding the bone, and nailed the patella to the tibia.

Fig. 1639. Fig. 1640.



Perforation of Bone by Modern Bullet.

GUNSHOT WOUNDS OF JOINTS.

Two causes have greatly modified military surgery. One is the use of the new army rifles, which deliver bullets of very small diameter at the enormous velocity of over 2000 feet in a second, and the other is the more systematic use of antiseptics on the field of battle. Nearly all the great military nations have changed their guns, especially Germany, France, England, and Austria, and the United States of America.

Fig. 1641.

Comminution of Bone by Modern Bullet.

The new Springfield rifle has a calibre of only thirty one-hundredths of an inch, and the guns of the other principal nations are of nearly the same size. The bullet consists of lead, or lead and antimony, wedged into an elongated thimble of German silver, which gives the projectile a hard surface, and prevents it from being knocked out of shape or cut to pieces when striking a bone. It is considerably longer than the old bullet.

These peculiar projectiles with their high velocity often perforate a bone in a remarkable manner, causing but little shattering, especially if the perforation is in cancellated tissue.

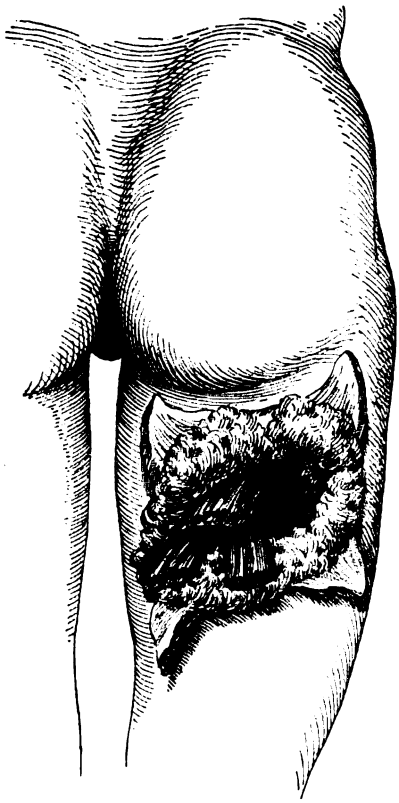
Figs. 1639 and 1640 show a bone perforated by a modern bullet fired at a medium distance, at which it has a singular power of making clean perforations.

At short distances, however, the modern ball acts differently. When striking the brittle surface of the middle of a long bone, the shaft is smitten into numerous small pieces as shown in Fig. 1641. The bullet going at 2000 feet a second drives these pieces before it, causing them

to spread out in the form of a cone, and to act as if the bone had actually exploded. The bullet and the fragments rush out of the limb in a cluster, tearing the tissues wide open, as in Fig. 1642, making frightful wounds, with everted edges. The fragments of bone and bits of flesh are often driven 20 or 30 yards beyond the patient.

This pseudo-explosive action, however, is not peculiar to the new rifle, as some writers seem to suppose. It was often seen in the War of the Rebellion, when the old Minié bullets struck the shaft of the femur or of the tibia. The tearing, semi-explosive action caused great surgical shock, which was frequently fatal. When the new bullets strike joints at a medium distance from the gun, they often make clean perforations, which admit of being searched and disinfected, and they will allow of saving in many cases a useful articulation, when the old bullets would have shattered the joint, permitting nothing short of amputation or excision.

Fig. 1642.



Laceration of Soft Parts in Gun-shot Fracture by Modern Bullet.

At long distances the new projectiles produce wounds much like those of the old kind when moving at corresponding velocities.

Another difference between the new wounds and the old is due to the structure of the bullet. The simple bullets of soft lead, whether round or conical, used to spread out, on striking the bone, into very singular forms, and in multitudes of cases were cut to pieces by the bony edges, producing fragments the smaller of which lodged in the injured parts, while the larger often flew on as separate projectiles.

The remarkable tendency of soft lead bullets to be torn to pieces on striking a bone developed a singular theory as to its cause. It was seriously argued by some authors that on striking a bone the sudden arrest of velocity in the bullet caused its motion to be converted into heat, suddenly melting the lead, and causing it to be dashed about in the tissues as a spray of liquid metal.

To one intimately acquainted with the phenomena in question this theory is absurd. After carefully studying a great number of these fragments of lead, I assert without fear of contradiction that they are always chips and raspings, showing clearly the striæ where the rough bone has scratched the surfaces. Neither in battle nor in my numerous cadaver experiments have I ever found a single piece of lead, large or small, showing any of the forms peculiar to the molten condition; nor any cauterized surfaces of tissue such as molten lead would produce. Mr. Victor Windett, a distinguished engineer, has shown by careful cal-

culations that if the whole onward motion of a bullet weighing half an ounce and moving at 2000 feet a second were instantly arrested, and converted into heat, it would only raise the temperature to 351° F., which is 284° below the melting-point of lead.

It is evident, therefore, that the deforming and comminution of the old projectile on striking a bone were purely mechanical. The new bullets are neither cut nor rasped to pieces. Being swedged into a slender but pretty strong thimble of German silver, the hard casing prevents both the spreading of the end on striking a bone, and the cutting and rasping of the metal as it goes through, so that in gunshot wounds of joints we now have in many instances a comparatively smooth perforation, with only a few radiating cracks around it. This is in striking contrast with what we found in the wars of past times, where we had to operate on joints literally reduced to a handful of bony gravel, interspersed with chips of lead.

The simpler modern wounds admit in many cases of complete disinfection, and consequently of successful treatment without amputation or resection.

Field surgery has not yet fully tested the effects of the new guns, but we are safe in drawing the following practical conclusions:—

1. When a joint is wounded, whether by a bullet, a piece of shell, a splinter, a knife, or a bayonet—in short, by anything not known to be perfectly aseptic—no conclusion should be drawn from mere outside inspection. The soldier should be anæsthetized, and the surface scrubbed with a solution of bichloride of mercury of the strength of one part to 2000 of water, or if, in the exigencies of battle, the bichloride is not at hand, then with tincture of iodine, alcohol, or any other antiseptic.

2. Still proceeding antiseptically, the surgeon should examine the wound. Synovial effusion, or the depth and direction of the wound as shown by a probe, often settles the question at once whether the capsule of the joint is perforated. If he is not clear as to this point, the surgeon should slit up the track of the ball to any extent necessary to allow a complete search for an opening in the capsule. If none is found, then the treatment is simply antiseptic.

3. If the bullet has merely grazed the capsule, making a slight rent, free from any evidence of dirt, bits of clothing, etc., and has not fractured the bone, and if also the wound is examined immediately after the injury, then the interior of the capsule will probably not be infected. The track of the bullet can be scraped or shaved with the scalpel, thoroughly disinfected, and closed up antiseptically, with a prospect of success.

4. If the bullet has gone deeper, passing through the joint, or even gouging its bony edges, the wound must be considered as infected.

In the Russo-Turkish war, Reyher advocated dissecting around the orifices of entrance and exit, and sealing up the wounds. He had a certain moderate amount of success, as things went in that pre-antiseptic time, but his method will not answer in future battles.

In the cases under consideration it must be remembered that the soldier's clothing is very foul with sweat, dust, and mud. His skin is in the same condition. There is nothing clean from head to foot about a soldier in battle. The track of the bullet which has traversed his clothing, or even the skin alone, is infected from end to end. It is

therefore necessary to lay the joint widely open, inspect its interior, remove fragments of bone or cartilage, cleanse the whole with antiseptic solutions in the most thorough manner, and then, if the joint surfaces are not shattered, close up the wound antiseptically, using drainage if the parts are much injured.

If, however, the joint is badly comminuted, resection may be necessary, and if the shattering extends too far from the joint, or if the principal nerves and vessels are destroyed, amputation is usually required.

The deadly experience of former wars firmly settled for that time the rule that excisions of the knee joint for gunshot wounds were not ordinarily justifiable, the mortality being too great, but the advent of antiseptics has again brought up the question.

We have had no great wars yet with a full trial of antiseptic excisions of the knee, and, beyond doubt, it will be very difficult in the exigencies of rapid marching and fighting to excise a soldier's knee, and put it up in such a secure way that he can be hauled a hundred miles in an ambulance, and come out all right. In light marching, the surgeon cannot have several barrels of plaster-of-Paris for dressings, yet binder's board or thin elm splints might be furnished, and would serve for short trips to general or steamer hospitals. Where long ambulance hauling is not required, there seems no reason why military resections of the knee should not have a reasonable success under antiseptic conditions, and the question will therefore come up again, and will have to be decided by the experience of future wars.

As to the shoulder, elbow, and wrist, exsections succeeded admirably in former campaigns, and will no doubt do still better in those of the future. The question of excision or amputation is to be decided in the superior extremity much as it is in civil practice, that is to say, excision is preferable to amputation unless the circulation is so far destroyed that mortification is inevitable, for even a slightly useful hand is far preferable to none at all.

The articulations of the cranium, being firm sutures, with no synovial membranes, scarcely require special consideration. The new weapon has, however, introduced a form of injury little known before. In many cases the bullet in entering gives such a sudden expansion or out-fling to the substance of the brain as actually to burst and shatter the bony walls of the cranium. This is probably explicable by the law of hydraulics, that fluids—and the living brain is a semifluid substance—transmit force equally in all directions, and there is an experiment which gives analogous results. If a bullet be fired from one of the new guns through an empty tin flask, it merely perforates it, but if the flask be filled with water and the stopper put in, the bullet will not only pierce the tin, but shatter the whole flask.

As far as practical management is concerned, gunshot wounds affecting the articulations of the cranium must be treated precisely like fractures of the skull in general.

Punctured, Incised, and Lacerated Wounds of Joints.

Punctured wounds of joints, as well as incised, contused, and lacerated wounds, are to be treated much like gunshot wounds which have

not fractured the bones. That is to say, the wound should be carefully explored, the orifice being freely enlarged when necessary, and if the interior of the capsule is likely to have been infected with septic material, it should be laid open, thoroughly disinfected, and closed antiseptically, drainage being provided if the interior is materially injured, or is believed to be decidedly infected with septic material.

DISEASES OF THE JOINTS.

BY

ROBERT W. LOVETT, M.D.,

ASSISTANT SURGEON TO THE CHILDREN'S HOSPITAL, OUT-PATIENT SURGEON TO THE BOSTON CITY HOSPITAL, AND SURGEON TO THE INFANTS' HOSPITAL, BOSTON.

PROBABLY no department of Surgical Pathology has experienced a more radical change in the last ten years than that relating to diseases of the joints. Not that new diseases or new conditions have been discovered; simply that old and well-known pathological conditions have been differently interpreted. Tuberculosis, which occupied a comparatively minor place in the old system, has come forward to take the chief place in the joint pathology of to-day. Perhaps we attribute too much to it and allow it more scope than it deserves, for the pathology of bone and joint disease is a department of much uncertainty. It is indeed a transition time in these matters: no classification worthy of the name exists, and there is no authority in the matter weighty enough to establish a classification which would be accepted by all. Syphilis and rheumatism are unknown factors to a large extent, and their pathological and clinical manifestations are often confused with those of tuberculosis.

The chief duty, then, of one who would record the progress of the last ten years must be to state briefly on what grounds the various affections have been accepted as tuberculous, and what influence this must have upon their treatment. Synovitis and articular osteitis will be considered from this general point of view, and then attention will be paid to the diseases of the individual joints with especial regard to the more recent methods of treatment.

SYNOVITIS.

SIMPLE ACUTE SYNOVITIS.—Simple serous synovitis deserves no especial mention, as no modification of note has taken place in the views held by surgeons with regard to it, except in the general direction which has already been indicated. More cases are recognized as instances of tuberculosis than formerly. Especially is this true in children, where it is urged that a diagnosis of acute synovitis should be made with very great circumspection, and only after recovery has taken place. As hip disease, for example, has been studied, it has been seen that many a case remains latent until some fall calls into being the active symptoms. These follow immediately upon the traumatism and are naturally enough attributed to it, whereas a chronic osteitis was

already present. These cases are so common as to be every-day matters in large orthopædic clinics.

Again, simple acute synovitis in children often passes directly into a chronic tuberculous synovitis. This is to be particularly noted in the knee, when the progress of the affection can be watched. These cases begin in the common way, and show no signs by which they may be recognized in advance. Hence it seems merely a precaution of common wisdom to urge that all cases of acute synovitis in children should be regarded as suspicious until permanent recovery has taken place. Simple acute synovitis is not a common affection in young children, while joint tuberculosis is.

Treatment.—The treatment of simple acute synovitis is for the most part unchanged. The use of cold, heat, and pressure, in connection with rest, is still the treatment of the best authorities. Rest is the essential, and such experiments as those of Phelps [1] show how little is the danger of anchylosis from joint fixation. It has been shown plainly enough that fixation *per se* does not produce anchylosis in healthy joints.

A question in the treatment of simple synovitis which has assumed a semi-scientific aspect, is the immediate application of passive movement and massage. Such books as those of Mansell-Moullin [2] bring the matter before the profession and entitle the treatment to consideration from a critical standpoint. A quotation will show the tendency of the book: "As a rule, passive movement may be commenced from the second day with the certainty of preventing adhesions and without the least fear. . . . Supposing the case of a sprained ankle of moderate severity in a healthy person a few hours after the accident; the ligaments are strained, perhaps even slightly torn; the synovial cavity is distended with fluid, etc. . . ." In this case Moullin recommends massage.

This will serve to show the extent to which the advocates of this theory would push it. They recognize no limitations as a rule, and an article may be found recommending even the immediate treatment of intra-articular fractures by massage and manipulation, and quoting successful cases [3] treated in this way.

With regard to the immediate treatment of synovitis by massage, it can only be said that it is not sanctioned by general surgical authority. That with a few exceptions those most used to the treatment of joint injuries advise immediate and complete rest, to be followed by massage when heat and active signs of inflammation have wholly or partly subsided. In slight sprains massage answers admirably, in severe sprains it is occasionally tried with signal success, but most surgeons will call to mind cases where the results have been most unfortunate. So that it may be said that, in simple acute synovitis, he who advises immediate massage recommends a treatment which is not generally sanctioned by the best surgeons, and which is attended with a risk of increasing instead of controlling the disease.

Acute Purulent Synovitis.—The chief point in regard to acute suppurative synovitis which the researches of late years have developed, is the recognition of germs in the joint fluid in acute infectious diseases.

[1] New York Medical Journal, May 17, 1890.
[2] Mansell-Moullin, Sprains. London, 1887.
[3] Lyon Médical, t. lvii., p. 12.

The gonococcus has been found in the joints in the synovitis of gonorrhœa, the pneumococcus in the joint disease occasionally occurring in pneumonia. These serve only to establish more fully the fact that these joint affections are distinctive, and are an integral part of the general disease in such cases.

The treatment of acute suppurative synovitis is more vigorous than in former days. Early free incision of the joint, thorough antiseptic irrigation, and drainage if necessary, are the accepted methods. Early aspiration of the pus, with washing out of the joint through the aspirating tube until the fluid returns clear, is advocated by such men as Mayo Robson, and in the early stages yields good results. If it fails, incision of course is required. Prolonged rest to the affected joint is necessary after operation, especially in the case of children.

Tuberculosis of Bones and Joints.

The names of strumous and scrofulous joint disease are best omitted in the present connection, and the affections formerly called by these names are to be classed as tuberculous. The situation is fairly well stated by Dr. Peters,[1] who says that those who do not recognize the identity of scrofula and tuberculosis are "such surgeons at home and abroad as do not perhaps enjoy the privilege of closely following the rapid advance of pathological investigation."

It can be stated very briefly upon what evidence these diseases are classed as tuberculous, and it is the more necessary to do so because Mr. Barwell was unwilling to accept the evidence of ten years ago; but the last years have been so fruitful in investigation in this direction, and the investigations so convincing, that to-day the question must be considered as to a large extent settled.

The Presence of Bacilli.—In the first place, tubercle bacilli are found in the affected structures. When they were first looked for, the results of investigation were unsatisfactory and imperfect; Kanzler, for example, found bacilli in only 8 out of 15 cases examined; this, however, was in 1884.[2] But with the perfection of the methods for their detection, the investigator of to-day is reasonably sure of finding the bacilli in the tissues affected by "strumous" joint disease. Castro Soffia, in 1885,[3] never failed to demonstrate the existence of bacilli, nor did Schuchardt and Krause in examining 40 cases of surgical tuberculosis from the clinics at Halle and Breslau.[4] The bacilli are generally very few in number, and persistent search may be needed for their detection, and even expert observers are occasionally obliged to give up the search.[5] In the pus they are even harder to find than in the joint tissues. Mogling[6] was able to find them in all of 53 cases that he examined, but Schlegtendal,[7] in 520 specimens of pus from tubercular abscesses, only

[1] Canadian Practitioner, 1890; see also, Treves, Manual of Surgery; Howard Marsh, Diseases of Joints, p. 7; Hueter, Gelenkkrankheiten; Id., Archiv f. Chirurgie, 1879, Bd. xi.
[2] Berliner klinische Wochenschrift, 2 Jan., 1884.
[3] Thèse de Paris, 1885.
[4] Fortschritte der Medicin, Mai, 1883.
[5] Müller, Centralblatt f. Chirurgie, 1884, No. 3.
[6] Die Chirurg. Tuberculosen. Tübingen, 1884.
[7] Fortschritte der Medicin, Bd. i., S. 537.

found the bacillus of tubercle in about 75 per cent. Experiments have, however, repeatedly shown that pus in which no bacilli can be detected is capable, when inoculated, of producing tuberculosis, so that in the 25 per cent. of cases in which the bacilli could not be identified they were undoubtedly present, as indeed Schlegtendal admits.

INOCULATION EXPERIMENTS.—Another and most important link in the chain of evidence that strumous joint disease is really tuberculous, lies in the fact that inoculation with the diseased joint tissue produces general tuberculosis in animals. Tavel, for instance, has used this as a means of diagnosis. On inoculating material from so-called strumous joints he found that in Guinea pigs it invariably produced diffuse tuberculosis and death in from five to six weeks.[1] The experiments of Schueller have become classical. After rendering the animals tuberculous by the injection into their lungs of tubercular tissue, the knee-joints on the right side were damaged and were found afterward to develop a form of fungous joint-disease similar to "tumor albus." Mr. Barwell was the chief objector to these experiments, which he did not consider conclusive; but in the light of further experimentation it must be admitted that they established at least as much as Schueller claimed.[2]

Another most conclusive point is the fact that injection of pure cultures of tubercle bacillus into the joints causes a fungous joint-disease of the type known formerly as strumous or scrofulous. Pawlowsky[3] found that an intra-articular injection of a pure culture of tubercle bacilli produced a tuberculous synovitis in animals in four days. At the end of three weeks the process had advanced to the stage of granulation tissue and suppuration, and microscopical examination showed the tissues thoroughly infected with the bacilli. The injection of inorganic material into the joints does not cause tuberculosis.

The most convincing experiments of all were those of Müller,[4] who produced a typical tuberculosis of bone by the injection of tubercular material into the artery supplying the tibia. The experiments were made chiefly upon young goats, and the resulting bone lesions were identical with tubercular bone lesions as found in man. In one case where the animal was killed thirteen months after the injection, a typical fungous disease of the knee-joint was found, and bacilli were constantly found in the diseased structures. Cheyne[5] produced a typical synovial tuberculosis which afterward went on to arthritis, in a rabbit, by the injection of tuberculous sputum diluted with distilled water; and tubercular pus put into the femoral artery of a rabbit produced a cheesy mass in the upper part of the tibia, near the epiphysis. The injection of an emulsion of a pure culture of tubercle bacilli into the knee-joints of several rabbits produced in every instance a typical tuberculosis of the joints. Krause in the same way produced tuberculosis of joints in rabbits by the injection of pure cultures of tubercle bacilli. These experiments show plainly enough that tubercle bacilli are capable of causing typical joint disease of the type that we recognize as tuberculous.

[1] Senn, Tuberculosis of Bones and Joints, 1892, p. 13.
[2] Hueter, D., Archiv f. Chirurgie, 1879, Bd. xi., S. 317.
[3] Annals of Surgery, vol. x., p. 225.
[4] Centralblatt f. Chirurgie, 1886, S. 233.
[5] British Medical Journal, April 11, 1891.

GENERALIZATION OF TUBERCULOSIS.—Another evidence of the tubercular character of these joint lesions lies in the fact that so many of the patients ultimately die of generalized tuberculosis. Cheyne states that of 386 patients who had bone or joint tuberculosis, 10 per cent. died of phthisis, or some other form of tuberculous disease, within a period of three years after the end of treatment. Of 2106 cases of tubercular disease of the bones and joints, Billroth and Menzel found that more than half were complicated with tuberculosis of the internal organs. Koenig believed that in only about 20 per cent. of cases of joint tuberculosis was the disease confined to the joint affected. Neumeister collected 438 cases of tubercular joint disease, and found that 10 per cent. of the patients had died of generalized tuberculosis.

PRESENCE OF TUBERCLE STRUCTURES.—In addition to this, there is the evidence afforded by the microscope of the existence of tubercle in the diseased tissues. This evidence is, of course, less convincing to the general mind than the direct production of this form of joint disease by experiment, but it nevertheless points in the same direction.

These experiments and investigations would seem to show that the type of chronic joint disease known by the various names of strumous, scrofulous, and fungous, is in reality a local form of tuberculosis, and that this statement rests upon the soundest pathological and scientific basis. The matter has been entered upon at length because the position here taken is the outgrowth of the work of the last ten years, and must needs be recognized by all who have to deal with the treatment of chronic joint disease.

LOCAL TREATMENT OF TUBERCULOUS JOINT DISEASE BY TUBERCULIN.—It was hoped that with the introduction of Koch's method for the treatment of tuberculosis a new era had begun in the treatment of tuberculous disease of the joints. The history and the failure of the tuberculin treatment are matters of medical history, and the reader will have no difficulty in finding exact directions for the use of the remedy as it was advocated by the originator. The idea of Koch was that the remedy did not kill the bacilli, but attacked the tubercular tissue and not the healthy structures, which gave clearly a limit to the inflammation that attended its use; and the action of the remedy certainly was an increase of irritation in cases of surgical tuberculosis. When the fluid was injected into the subcutaneous tissue of the back, tubercular joints became swollen, red, and irritated. It was hoped that not only would tuberculin serve as a remedy in surgical tuberculosis, but that it might be utilized as a diagnostic sign in cases of tubercular disease. Neither of these anticipations has been realized.

Its first use in affections of the joints was made by Bergmann, and from the 16 cases analyzed by him he was led to anticipate that in certain cases its employment would be attended by brilliant results. Hahn[1] reported 59 cases of surgical tuberculosis treated by Koch's method, and reported that 16 were considerably and 12 noticeably benefited. In tubercular joint disease the results were better when sinuses existed

[1] Deutsche med. Wochenschrift, 1 Jan., 1891.

than when there was no outlet. Socin [1] tried the method in 20 cases with unsatisfactory results. Verneuil [2] claimed that an authentic and permanent cure of surgical tuberculosis by the use of Koch's lymph had not been recorded at the time of his writing in 1891.

Among the papers written by surgeons who have obtained favorable results from this treatment are those referred to in the foot-note.[3]

An attack upon this method of treatment was made at the Second Congress of Tuberculosis, July 27, 1891. It was demonstrated by Arloing, Rodet, and Courmont that the curative effect of tuberculin in cases of bird, bovine, and human tuberculosis occurring in animals, was practically nothing, and finally the assertion of Koch that the Guinea pig was given immunity against tuberculosis by treatment with tuberculin, was disproved. It was stated, indeed, that in many cases animals thus treated developed more confluent tubercular lesions, and with greater tendency toward speedy degeneration.

Dr. Senn [4] gives the history of 53 cases of tuberculosis, 43 being cases of pulmonary phthisis, and 10 cases of surgical tuberculosis, and as his conclusion from this experience speaks as follows: "I have given Koch's lymph a fair trial, and have carefully observed its results, and have become firmly convinced both of the danger which attends its use and of its utter inutility in curing any form of tuberculosis." He protests, moreover, "earnestly against further experimentation with this mysterious and dangerous fluid."

A purified preparation of Koch's lymph, called by its advocate, Professor Klebs of Zurich, Tuberculocidin, has been advocated on the ground that the toxic substances which produced the unfavorable features in Koch's lymph have been done away with, and that the therapeutic value of the preparation is equal to that of tuberculin, but so great was the distrust engendered. by the failure of Koch's tuberculin treatment, that Klebs's newer remedy has aroused but little interest.

TREATMENT BY INJECTION.—Within the last few years the treatment of tuberculosis of the joints by the direct injection of some remedy has been advocated. The proceeding has not as a rule found favor so much with orthopædic surgeons as with general surgeons in certain parts of this country and in Germany. I have had personally little or no experience in the use of these parenchymatous injections, but have depended largely upon the admirable account given of the method by Professor Senn in his "Tuberculosis of Bones and Joints." Tincture of iodine, arsenious acid,[5] carbolic acid,[6] corrosive sublimate,[7] phosphate of lime,[8]

[1] Correspondenzblatt f. Schweizer Aerzte, 1891, H. 1, S. 91.

[2] L'Union Médical, 22 Janv., 1891, p. 24.

[3] Bericht über die Anwendung des Koch'schen Heilmittels bei Kranken; von Esmarch, Deutsche med. Wochenschrift, H. 3, S. 4, 1891. Mittheilungen über das Koch'sche Heilverfahren; H. von Burkhardt. Med. Corresp.-Blatt des Würt. ärzt. Landesvereins, 18 Dec. 1890. Das Koch'sche Heilverfahren combinirt mit chir. Eingriffen; Sonnenburg, Deutsche med. Wochenschrift, H. 1, 1891. Mittheilungen über das Koch'sche Heilverfahren aus dem Kaiser Franz Josef Kinderspital in Prag; Ganghofer und Bayer, Prager med. Wochenschrift, No. 34, 1891. Das Koch'sche Heilverfahren in Spital Munsterlingen; Kappeler, Corresp. f. Schweizer Aerzte, 1891.

[4] Chicago Medical Recorder, June, 1891. [5] Cavagnis, Études de la Tuberculose, p. 462.

[6] Die Wirkungen der parenchymatosen Carbolinjectionen bei Entzündungen der Gelenke und Knochen. Deutsche Zeitschrift f. Chirurgie, Bd. iv., S. 526; Bd. v., S. 120. [7] Ibid.

[8] Korlischer, Ein neues Heilver. bei lokalisirten tuberculosen Processen. Wiener med. Presse, Bd. xxviii., H. 22, 1887. Ibid., Bd. xxviii., H. 24, 1887. Ibid., Bd. xxvii., H. 29. Centralblatt f. Chirurgie, H. 15, 1888.

chloride of zinc,[1] balsam of Peru,[2] and camphorated naphthol[3] have all found their advocates for this use. The treatment cannot be called strictly a new one, because several of these substances have been in use for many years—as, for instance, tincture of iodine as introduced by Brainard, of Chicago—in chronic inflammation of the joints; but the persistent and extensive use of irritating and germicidal substances into the diseased tissue is strictly the outcome of late years.

These various substances have found their respective advocates, as will be seen from the references given, but the majority of surgeons prefer the use of iodoform to that of any other drug.[4] Although it has been shown in the laboratory that iodoform may not be a germicide, its anti-tubercular action is thoroughly recognized from a clinical standpoint, and experimentally it has been clearly proved that a prolonged use of this article by subcutaneous injection in animals, prevents or at least retards the extension of tuberculosis. However that may be, the treatment of chronic tuberculosis of the bones and joints by the use of iodoform is a matter of very great importance, because it is not only supported by a great weight of surgical authority, but offers a reasonable ground for hoping that it may take the place under certain restrictions of more radical operative measures. The iodoform is generally injected in sterilized glycerin or olive oil. A 10-per-cent. preparation is used, and it is said that not more than half a drachm of iodoform should be injected the first time, and in children less than this. It is stated by Senn that after its use in this manner the risk of iodoform intoxication is very slight, not a single case having been observed in 108 cases thus treated in the Tübingen Clinic and at Halle.

The treatment has been very extensively used, as for instance by Bruns,[5] who says[6] that, in the last five years, of 100 cases of tubercular abscesses treated at his Clinic, 80 per cent. have been cured, and that in the last four years 50 cases of joint tuberculosis have also been cured. A 10 to 20 per cent. mixture of iodoform is used in pure glycerin or olive oil, prepared fresh and thoroughly sterilized. No pain or inflammation follows the injection, although the temperature rises for a

[1] Lannelongue.

[2] Münch. med. Woch., H. 40, 1888. Wiener med. Presse, Bd. xxx., H. 17-20, 1889: Centralblatt f. klin. Medicin, Bd. x., 1889.

[3] Études expér. et clin. sur la Tuberculose, Paris, 1888-90, p. 608.

[4] Berliner klin. Wochenschrift, 1881. Arch. f. klin. Chirurgie, Bd. xvii., S. 3, 1882. Wiener med. Blätter, Bd. viii., H. 10-12, 1885. Berliner klin. Wochenschrift, H. 41, 1886; Ibid., H. 20, 1891. Supplement to British Medical Journal, July 8, 1891. Études sur la Tuberculose, 1 Juillet, 1887. De la Tuberculose Chirurgical, etc., Paris, 1890, p. 485. Anatomie Pathologique Générale. t. x., p. 616. Archives Générales de Médecine, 1829, t. v. Thèse de Paris, 1843. Archives de Physiologie, 1878. Clinique Chirurgicale des Maladies Chroniques, 1877. Études sur la Tuberculose, fasc. ii., p. 416. Revue de Chirurgie, 1885, p. 428 *et seq.* Ibid., 1886, pp. 476-502. Gazette des Hôpitaux, No. 146, 1887. Congrès de la Tuberculose, p. 586. Gazette Hebdomadaire, 1887. Revue de Chirurgie, Février, 1890. Étude expérimentale de l'action de quelques agents chimiques sur le Développement du Bacille de la Tuberculose, 1888. Archives de Médecine et de Pharmacie, t. xvi., No. 8, 1890. Verh. der Deutschen Gesellsch. f. Chirurgie, 1887. Beitr. zur klin. Chirurgie, Bd. vi., H. 3, S. 639, 1890. Centralblatt f. Chirurgie, H. 38, 1889. Bruns, Beitr. z. klin. Chirurgie, Bd. ii., 1887. Ueber die Behandlung kalter Abscesse in tuberculöser Caries mit Jodoform-Emulsion, Berl. klin. Wochenschrift, No. 49, 1890; Lond. Med. Recorder, 1889; Centralblatt f. die gesammte Therapie, 1887; Deutsche med. Wochenschrift, 1887; Centralblatt f. Chirurgie, 18 Mai, 1889; Berl. klin. Wochenschrift, 5 Oct., 1891; Beitr. z. klin. Chir., Bd. iii., Tübingen, 1887.

[5] Verh. d. Deutschen Gesellsch. f. Chirurgie, 1887.

[6] Beitr. z. klin. Chirurgie, Bd. 6, H. 3, S. 639, 1890.

day or two from one to two degrees. Bruns says that he has never met with cases of iodoform intoxication from these injections.

In connection with this I am tempted to speak of a case under my own observation, in which a sinus communicates with a diseased hip-joint of many years' standing. The patient is a physician of unusual intelligence. Iodoform bougies of three grains each were prescribed, one to be put into the sinus every night. The patient finds invariably that after the use of these bougies for a few days, an irritating coryza begins, and continues until their use is discontinued. After he stops using them the coryza immediately stops, only to return again after they are resumed. This case may perhaps serve as a contrast to those reported by the enthusiastic advocates of the use of large amounts of iodoform in closed cavities.

For two years Krause treated tubercular affections of the joints by intra-articular injections of iodoform, as follows:—

	Cases treated.	Cases cured.
Knee joint,	36	15
Hip joint,	13	4
Ankle joint,	6	1
Wrist joint,	5	3

Trendelenburg treated 135 cases by the injection method, and reported that in 68 per cent. there were favorable results. Comparatively few instances of serious poisoning have been reported in connection with this mode of treatment, though toxic effects have been noticed after an injection of only one decigramme of iodoform. The use of this remedy dissolved in ether is objectionable on account of the vaporization of the latter at the temperature of the body, which causes so much distention that it may even lead to gangrene in extreme cases.

It is said[1] that tubercular abscesses, treated by iodoform injections and examined at different intervals subsequently, show disappearance of the bacilli, and that ultimately the tubercles themselves disappear by fatty degeneration of the cells and liquefaction of the cellular detritus.

With regard to the treatment by iodoform injection, Senn says that its curative power has so far been most manifest in the treatment of what have been heretofore most hopeless cases of surgical tuberculosis—tubercular abscesses in connection with inaccessible osseous foci. In the successful cases not only abscesses but the primary bone lesions are also cured. This mode of treatment deserves consideration, as has been said, on account of the weight of authority in its favor; but at the same time it is evidently advocated by enthusiasts, and its real value must be regarded as something to be proven by careful and scientific experiment.

It must manifestly be unsafe to inject large quantities of iodoform into closed cavities in every instance, especially in the case of delicate children, and few surgeons who have used iodoform freely have been so fortunate as to escape without some annoying or alarming symptoms of iodoform intoxication. References have been given so that the reader may be able to judge for himself of the merits and the claims of this plan of treatment. If it be decided to adopt it, the joint or abscess cavity should be irrigated with a solution of boric acid, carbolic acid, or corrosive sublimate, until the fluid returns clear, and then

[1] Beitr. z. klin. Chirurgie, Tübingen, 1887.

a 10-per-cent. mixture of iodoform in glycerin should be thrown not only into the joint but into the thickened fungous capsule with an ordinary hypodermic syringe. The procedure should be repeated at intervals of a week, and each time at a new place in the joint contour. The ethereal solution should never be used, and the best method of using the iodoform is in the glycerin mixture. Senn says that from three fluidrachms to one fluid-ounce is the average dose. The strictest antiseptic precautions should be used, and the injections should be persisted in until the indications point to a cessation of tubercular inflammation, or until the result has shown the inefficacy of the treatment and the necessity of operative interference. However these injections are used they cannot be regarded as a substitute for mechanical measures, but should be employed in connection with the best orthopædic treatment obtainable.

Loose Bodies in Joints.

The only change that has occurred in the views held as to the formation of these bodies, lies in the recognition of the tubercular character of many of them which were formerly supposed to be due to other causes. The larger loose bodies are generally of some other origin, either occurring in cases of rheumatoid arthritis or being traumatic,[1] but the smaller loose bodies have of late been recognized as most often the product of tubercular inflammation. Although the bacilli of tuberculosis have not yet been found in them, they are capable of producing tuberculosis when inoculated.[2] They were at first thought by König[3] to consist purely of fibrin, the result of the tuberculous inflammation, but Schuchardt[4] and others[5] advocate the view that they are rather the result of proliferation of the synovial membrane, by which papillomatous growths are pedunculated and cast loose into the joint.

The modern treatment is removal by simple incision.[6]

Acute Arthritis of Young Children.

This affection of the joints, originally brought to the attention of the medical public by Mr. T. Smith[7] under the name of the acute arthritis of infants, is an acute osteomyelitis of the articular ends of the bones forming the joint. Researches of later years have merely served to show that the affection cannot be regarded as due to traumatism alone,[8] but that it is a septic process resembling pyæmia in most instances. Cultivations made from the cocci of acute osteomyelitis, when injected into

[1] Marsh, British Medical Journal, April 14, 1888. Shattock, Trans. Path. Soc. Lond., vol. xv., p. 206. Hueter, Cf. St. George's Hosp. Reports, 1867. Virchow, Die krankhaften Geschwülste, Berlin, 1863. Klein, Virchow's Archiv, Bd. xxix., S. 190. Kragelund, Centralblatt f. Chirurgie, 1887, S. 412.

[2] Wallich, La Semaine Medicale, 21 Nov., 1888. Senn, op. cit., p. 147.

[3] König, Centralblatt f. Chirurgie, Bd. xiii., S. 25.

[4] Schuchardt, Virchow's Archiv, Bd. cxiv., Heft 1, S. 186.

[5] Tillmanns, Archiv f. mikr. Anatomie, 1874, Bd. x., S. 425.

[6] Woodward, Boston Med. and Surg. Journal, April 25, 1889.

[7] St. Bartholomew's Hospital Reports, 1874, vol. x.

[8] Rosenbach, Centralblatt f. Chirurgie, 1884, No. 5, 1877, S. 289. Krause, Fortschr. der Medicin, 1884, Nos. 7 und 8.

joints, cause a violent purulent arthritis,[1] and Rosenbach has found the same coccus in furuncles, empyema, and pyæmia, so that we must infer that an acute septic process lies at the bottom of these cases. This form of joint disease at times occurs after the exanthemata,[2] and in other instances a source of purulent infection may be found in a suppurating umbilicus, an empyema, or the like. In many cases, however, we must adopt the suggestion of Roswell Park, and assume "that the infection may occur through the ears, eyes, nose, mouth, pharynx, respiratory passages, mucosa of the alimentary canal, or skin: . . . furthermore from any subcutaneous phlegmon however small."[3]

No form of coccus has yet been discovered in the acute arthritis of infants which is different from the cocci of acute osteomyelitis, so that, as stated by Park, the conclusions are that "(1) there is no specific microbe for the production of acute infectious processes in bone; (2) most of the staphylococci can cause them, and exceptionally the streptococci; (3) the staphylococcus aureus is the most pernicious of all forms." In short, this acute joint infection is to be regarded as a form of pyæmia; ten years ago it was conjectured that such was the case, but to-day the statement rests upon excellent pathological evidence.

It is probable, however, although not definitively established, that certain forms of this acute arthritis are merely manifestations of joint tuberculosis of exceptional rapidity and virulence, qualities which are apt to characterize surgical tuberculosis in very young children.

Diseases of the Special Joints.

Hip-Joint Disease.—The treatment of Hip Disease has been the subject of much discussion of late years. Attempts have been made to formulate the results of practice, and ambulatory treatment has been both denounced and most warmly advocated. The many manifestations of tuberculous disease of the hip have been in part to blame for the varying conclusions, and I[4] have elsewhere attempted to classify for clinical purposes these variations in the disease, distinguishing four types or forms.

These are:—

(*a*) *The Destructive Form*, where the disease is rapid, severe, and but little influenced by ordinary treatment; extensive infiltration of the soft parts takes place, and in most instances the disease passes on to a fatal issue.

(*b*) *The Painful Form*, where pain is a prominent symptom, and exacerbations are common.

(*c*) *The Quiet or Painless Form*, where pain is an unimportant factor or is entirely absent.

(*d*) *The Transient or Ephemeral Form*,[5] where the symptoms are mild and the course of the disease is run in a few months.

It may be said that in general American orthopædic surgeons believe

[1] Id., Mikro-Organismen bei d. Wundinfections-Krankheiten, Wiesbaden, 1894.

[2] Holmes, Surgical Treatment of Children's Diseases. McLeod, Indian Med. Gazette, 1883, p. 232. Ancell, Archives of Medicine, 1830, vol. iv., p. 49. Asbby and Wright, Diseases of Children.

[3] American Journ. of Med. Sciences, July, 1889.

[4] Boston Med. and Surg. Journal, Oct. 13, 1892.

[5] Ibid., Aug. 18, 1892.

in and practise ambulatory treatment with a long traction splint, variously described as the Davis, Taylor, or Sayre splint. That the results by this method are so good that early resection is not practised by the representative men, but is regarded as a measure to be adopted when mechanical treatment has failed and the general condition of the patient is becoming bad. In these cases it is rather to be regarded as a life-saving measure than as an operation likely to yield brilliant results. English surgeons, however, incline much more to early resection,[1] and do not regard the "American method," as the traction method is called, with favor. In place of the long traction splint, cases are treated by bed extension, and when the time for going about has arrived, by the Thomas fixation splint.

It is hard to arrive at any correct idea of the comparative value of the two methods by any comparison of sets of figures. One can only conclude that in view of the serious nature of the disease the results by either method are surprisingly good. In suppurative cases, Shaffer and Lovett[2] reported 26 which had been investigated from four to ten years after the cessation of treatment by traction: 2 patients had recovered with perfect motion, 3 with 90° of motion, 5 with from 10° to 45°, 4 with slight motion, and 12 with anchylosis. Howard Marsh analyzed 37 suppurative cases one year after discharge. These cases had been treated by rest in bed with extension, and afterwards the Thomas splint. In the 37 cases he found one with perfect joint motion, free movement in 10 cases, slight movement in 7 cases, and anchylosis in 18 cases.

It would seem on general principles that cases treated without continuous traction should show a greater elevation of the trochanter than would cases treated by traction, and that traction must exercise a quieting influence on the joint which cases treated by fixation alone can never obtain. By a combination of traction and fixation, a method which will presently be described, it would seem that the advantages of both plans might be secured.

With regard to the merits of excision as compared with mechanical treatment, there are two factors to be considered: (1) the mortality rate in the two methods; and (2) the functional results to be obtained.

(1) *The Mortality Rate in the Two Methods.*—Mr. Wright,[3] in analyzing 2461 cases of hip excision done with and without antisepsis, found a mortality percentage of 34 per cent., the older groups, such as Leisrink's,[4] giving 63.6 per cent., and Culbertson's 41.6 per cent. in 418 cases.

Bradford and Lovett give a table of results of excision under modern conditions as follows:—

	Mortality per cent.
Volkmann, 48 cases.	25.30
Korff, 33 "	48.5
Grosch, 166 "	36.7
Alexander, 36 "	30.6

That is to say, the immediate mortality of excision, not counting the remote results, is not less than 30 per cent. The operation has

[1] Barker, British Med. Journal, June 9, 1888.
[2] New York Med. Journal, May 21, 1887.
[3] G. A. Wright, Hip Disease in Childhood.
[4] Arch. f. klin. Chirurgie, Bd. xii., S. 177.

been advocated as a means of preventing the generalization of tuberculosis, but that this result is not obtained is shown by such figures as those of Koenig,[1] who reported that in 21 cases of hip excision, 47.6 per cent. of the patients died of tuberculosis inside of four years.

In 837 cases of resection analyzed by Wartmann, it was found that 10 per cent. of all deaths were the result of rapid miliary tuberculosis, and Mr. Barker, a warm advocate of early excision, says that in 10 per cent. of all deaths following the operation "rapid miliary tuberculosis came on in such a way as to suggest strongly, if not to prove, that the surgical interference was the cause of the generalization of the disease."

(2) *The Functional Results to be Obtained.*—In 100 cases analyzed by Mr. Wright, another warm advocate of excision, the results were as follows:—

Soundly healed,	17
Unhealed,	57
Dead or dying,	18
In bad condition,	3
Amputated,	4
Recent case, doing well,	1
Total,	100

In analyzing this table it appears that about 20 per cent. of the cases may be classed as unsatisfactory. As 30 cases had been in progress only nine months or less when excision was done, they represent the most favorable class for operation, and we should look here for the best results. If compared with the results given above as obtained by mechanical treatment, it is easy to see that they are manifestly inferior; indeed this might be anticipated, because removal of part of the bone necessitates shortening, while destruction of the joint capsule and of the ligaments must necessarily leave a less efficient joint than can be obtained by any process less destructive in its character.

The London Clinical Society's Committee[2] investigating the question of hip excision, report "that the limb after treatment by rest and extension, though frequently more or less fixed, is more firm and useful for purposes of progression."

Grosch[3] declared as the result of an extensive analysis of cases of hip excision, that the results were no better than they had been before the days of antisepsis.

In reviewing these figures, which have been presented very briefly, it does not seem that the case for excision is a very strong one. Evidently the mortality rate is high, and if one considers the remote deaths following excision, it is much higher than by conservative treatment. The operation does not prevent systemic infection, as has been claimed for it, and its functional results are not so good as after mechanical measures. It is difficult, therefore, for an American surgeon to understand on what ground Mr. Barker, for instance, can advocate excision of the hip joint "as soon as it is suspected that caseation is advancing in it," until Mr. Barker explains that he regards "tubercle in the light of a malignant growth," and of course would deal with it by most radical means. Of course, if one believes as Mr. Barker does, the position of such extremists as Mr. Wright and himself can be under-

[1] Arch. f. klin. Chirurgie, Bd. xxvi., S. 822.
[2] Transactions of Clinical Society, vol. xiv., p. 234. [3] Centralblatt f. Chirurgie, 1882.

stood; but the remarks of Mr. Howard Marsh [1] furnish a fair statement of the position of the matter as it appears to most surgeons: "It is impossible, however, to shut one's eyes to the fact that this is an estimate of tuberculosis which the great majority of surgeons would not for a minute entertain. The estimate formed by Brodie, indorsed by Paget and Hilton, and accepted by a very large majority of those who have studied the subject from a clinical point of view, is that, though often intractable and destructive in its later stages, tuberculosis on a general survey wears the aspect of simply an obstinate, inflammatory process, the whole course and progress of which are widely divergent from those of malignant disease."

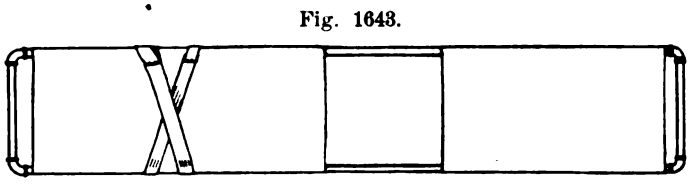
Yet in a very extensive experience Mr. Wright has reached no more temperate conclusion than "that treatment short of excision, when once suppuration occurs, is useful only as a palliative, or means of temporizing."

It may be said again, therefore, with regard to the comparative merits of mechanical treatment and excision of the hip-joint, that modern American opinion inclines toward a thorough trial of mechanical treatment, and that excision is to be regarded as a last resort, done as a life-saving measure, when mechanical treatment has failed, or as an inferior substitute for mechanical treatment in the case of the children of poor and destitute parents, who are out of the reach of hospitals, and for whom mechanical treatment cannot by any possibility be obtained.

Treatment by Recumbency.—The mechanical management of hip disease is conducted either by extension during recumbency or by ambulatory treatment. Extension during recumbency is to be preferred to ambulatory treatment when the disease is so acute that the hip is sensitive to jar, when night cries are present to any extent, and when attempts at going about with suitable apparatus cause pain and irritability of the joint. It is also to be adopted when deformity of the leg due to muscular spasm is present; when the child should rest in bed and traction should be made in the line of the deformity. In short, irritability of the joint and deformity are the two indications for bed extension.

Extension in bed is most simply applied if the child is placed flat upon the back and prevented from moving and turning in bed. This is

Fig. 1643.



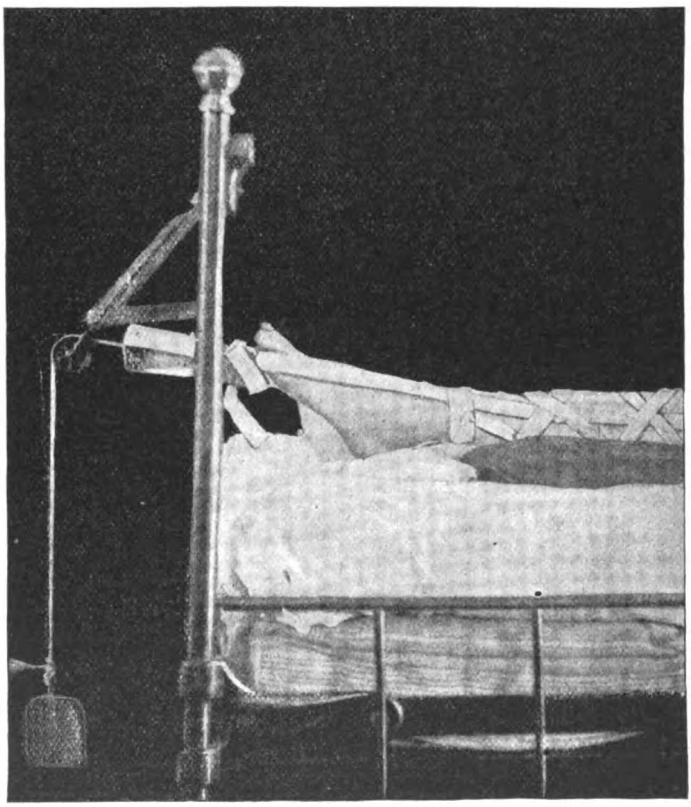
Bradford's Bed-Frame.

almost an essential to the success of the treatment. The most simple appliance for securing this rest during recumbency is an oblong gas-pipe frame invented by Dr. E. H. Bradford, of Boston. This frame is covered with a stout cotton cloth, and is laced or buckled on the under side to keep it tight and unwrinkled. The cover to the frame is made in two pieces, leaving an open space under the pelvis so that the child need not be taken from the frame at any time, but that a bed-pan may be placed under the opening. (Fig. 1643.)

[1] British Medical Journal, July 20, 1889, p. 121.

This frame should be a little longer and a little wider than the child, who is secured to it by two straps crossing over the chest and passing under the frame. A towel is passed around the frame and the pelvis, securing fixation there. Extension is then made in the usual way by weight and pulley from the foot of the bed. (Fig. 1644.) This does away with the necessity of the long splint and the various appliances described to secure fixation. It forms a part of the routine treatment of hip disease in the Children's Hospital in Boston, and is gradually being

Fig. 1644.



Weight and Pulley Apparatus for Bed-Traction.

adopted elsewhere as the most useful aid to the treatment of hip disease by recumbency.

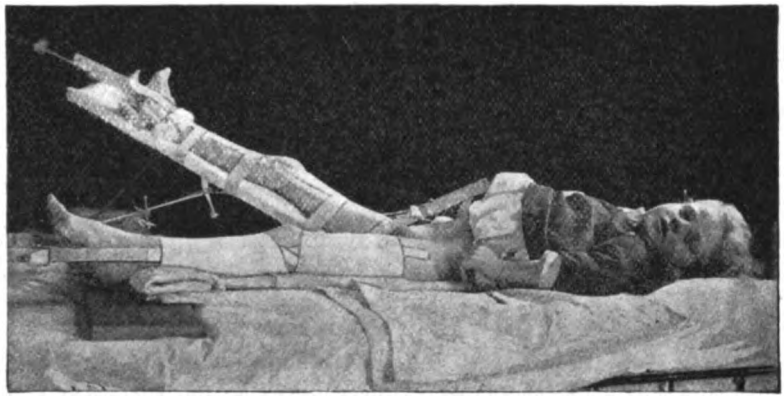
If deformity is present, the same frame is used, and the leg should then be pulled upon in the line of deformity, and supported in the deformed position by an inclined plane. (Fig. 1645.) Traction during recumbency may also be effected by applying a long traction splint to the limb. (Fig. 1646.)

Treatment by recumbency is in my judgment not to be advocated as a routine, long-continued method in hip disease; but simply as a temporary measure to meet the indications which have been noted. As a rule some ambulatory treatment is to be preferably adopted, making it possible for the tuberculous child to obtain exercise and air within the limits of safety to the joint. The place which recumbency should

occupy in treatment by ambulatory methods will be spoken of under the latter heading.

Treatment by Ambulatory Means.—Treatment by fixation after the method of Mr. Thomas has been discussed in full by Mr. Barwell [1] and

Fig. 1645.

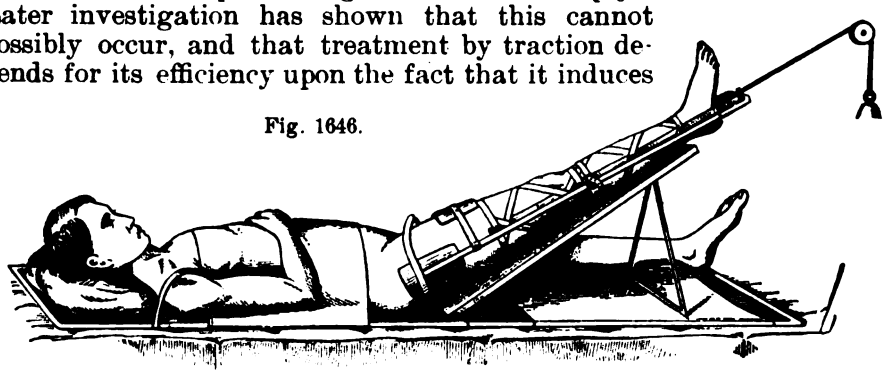


Bed-traction in a Case of Flexion and Abduction.

needs no further elucidation here. As has been said, it meets with much more favor in England than in America, and is to be considered as a method furnishing a fixation as complete as is possible by any simple apparatus, although far from being complete in reality.

The method of *ambulatory treatment by traction* [2] was based upon the fallacious idea of permitting motion at the hip-joint without friction. Later investigation has shown that this cannot possibly occur, and that treatment by traction depends for its efficiency upon the fact that it induces

Fig. 1646.



Traction Splint Applied During Recumbency.

a modification of intra-articular pressure, even separating the head of the femur from the socket.

Much experimentation has been done with a view of determining the question whether traction really separates the joint-surfaces or not. References are appended [3] to articles showing the sort of experiments

[1] See Vol. III.

[2] Argument with the Censor at St. Luke's Hospital, New York; London, 1889. Ridlon, Medical Record, Sept. 15, 1888. Shaffer, Transactions of the American Orthopædic Association, vol. ii. Judson, Medical Record, July 7, 1883. Lancet, Dec. 2, 1888.

[3] Transactions of American Orthopædic Association, vol. ii., p. 207. Bull. et Mém. de la

which have been made and the variety of conclusions which have been arrived at. Some recent experiments[1] upon the living subject, with and without hip-disease, have demonstrated that separation of the joint-surfaces may be produced by bearable and practicable amounts of traction.

The conclusions which may be drawn seem to be the following: That traction of ten pounds in children before puberty as a rule produces lengthening of the leg in hip disease, and that this lengthening is due to separation of the joint surfaces; that the amount of this separation varies in different instances, being in general less in older children than in young ones, and also varying in individual cases under apparently the same conditions, perhaps on account of some anatomical peculiarity; that twenty pounds of traction, as a rule, produces more separation than ten pounds.

It is probable that in the later cases of hip disease, where cicatrization of the capsular tissue may be supposed to have taken place, distraction is not as readily made.

It cannot be supposed that the best results can be obtained by the application of inefficient traction. A sufficient amount of traction, constantly applied during the stage of muscular spasm, is needed. It is, of course, not the only therapeutic measure which is required; fixation and protection are also needed at the various stages. If traction is not applied properly, or is applied at the wrong time, or is insufficient in extent, it is no more efficient than a drug injudiciously or wrongly used or administered at the wrong time. Judgment is required in the use of this measure as of any other, and a great deal of care and attention to detail not only on the part of the surgeon, but on the part of the nurses and assistants, is necessary to insure the constant application of from eight to ten or fifteen pounds' traction uninterruptedly for two or three or six months. It is owing to a defect in this respect that in many cases treatment by traction is ineffectual, and that the results obtained are not so satisfactory as desired. This leads to an unjust condemnation of the methods of traction-treatment by those who have tried this plan, and, having met with unsuccessful results, have blamed not their own mode of application, but the method in general; which is as irrational as if any one who should administer a drug in an insufficient dose should lay the failure to the drug, when it was properly due to its faulty administration.

The thorough use of traction—that is, to the point of distraction—requires on the part of the surgeon not only a familiarity with the mechanical details of apparatus, and the proper application, adaptation, and fitting of appliances suitable in each case, but the ability to arrange for such co-operation and assistance on the part of nurses or attendants as shall insure the continuance of the necessary amount of traction at all times. If, through the neglect of a nurse, a hip which needs continued traction of ten to fifteen pounds for protection against blows from muscular spasm, is left during an acute stage for a time with a traction of only two pounds, the joint may be seriously damaged.

Soc. de Chirurgie, 1886, t. xii., p. 31. Deutsch. Zeitschrift f. Chirurgie, 1873, Bd. iii., S. 256. Boston Med. and Surg. Journal, 1880, vol. ciii., p. 465; Ibid., August 30, 1888. Transactions of American Orthopædic Association, vol. i., p. 193.

[1] Bradford and Lovett, New York Med. Journal, Aug. 4, 1894.

If a number of pathological specimens of pronounced hip-joint disease are examined, it will be seen that the head of the femur has been crowded upward and backward. This in typical cases continues until the head of the femur is partially absorbed and the acetabulum enlarged, and finally a subluxation takes place, and the exaggerated pressure of the femur upon the acetabulum is diminished. After a while, in successful cases, cicatrization of bone follows, and ossification with resulting deformity—the deformity consisting of a shortened and adducted limb with subluxation, as indicated by the fact that the trochanter is higher than the Nélaton line.

The change from carious destruction is most marked in the upper portion of the acetabulum, and in the lower portion of the acetabulum there is evidence of repair in some of the specimens where there was no pressure.

From specimens examined it is clear that in hip disease the head of the femur is crowded against the acetabulum in a direction upward and backward, and that the process of repair is more advanced where the pressure is removed.

It is a well-known fact that in hip disease, in the acute or subacute stage, a reflex spasm of the muscles about the hip exists, this spasm being in proportion to the amount of inflammation of the joint.

The muscular pressure thus caused in disease is very much greater than is ordinarily supposed. Physiologists estimate the force of a muscle fully contracted at from six to ten kilogrammes to every square centimetre of muscular surface on cross section. In an adult, at the hip joint, the muscles connecting the femur with the ilium may represent from ten to fifteen square centimetres, and although these muscles are rarely contracted to their full extent, it is evident that the amount of force which they exert even when slightly contracted is by no means inconsiderable; and during an acute spasm, when the muscles are firmly contracted, the pressure driving the head of the femur upon the acetabulum must be very great even in a child. It is well known that the muscular spasm at its acute stage is both a tonic spasm and also an acutely exaggerated spasm on any jar or violence to the hip, or even on the apprehension of any jar or violence. This spasmodic stage subsides after a while, if the hip is kept absolutely free from motion, but it is a matter of experience that the spasm may persist for months, reappearing upon locomotion until the morbid process is entirely corrected and the inflamed bone has become solid. It is also known that fixation of the hip joint is a difficult matter, and that complete fixation (that is, the prevention of even the slightest motion) is impossible. The femur can be fixed, but the ilium can not. This is true for the reason that neither the thorax nor the abdomen can be compressed to the point of firm fixation, and that the lumbar spine is capable of more or less motion.

Furthermore, no amount of fixation can draw the head of the femur away from the acetabulum—that is, distract it—and pathological evidence would show that where pressure is entirely removed the process of repair is promoted.

It would appear, therefore, that if a pulling force can be applied which will not only counteract the spasmodic muscular force, but actu-

ally produce distraction, it will be desirable to employ it, this being entirely independent of any attempt to limit the motion of the hip joint.

The specimens represented by the annexed cuts (Figs. 1647, 1648) speak most emphatically for the thorough use of this method.

Fig. 1647.

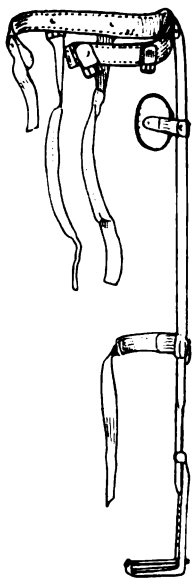
Head and Neck of Femur Without Traction.

Fig. 1648.

Head and Neck of Femur after Employment of Traction.

The specimen shown in Fig. 1648 is of the head and neck of the femur where excision was done after two or three years of efficient treatment by traction, but where the reparative process was not sufficient to establish a cure; the patient's general condition failed, and excision was resorted to. It is to be noticed that there is very little alteration in the shape of the head of the excised femur. This, compared with the specimen shown in Fig. 1647, an excision in a patient with hip disease of similar severity and duration where no traction had been applied, would appear fairly to show the effect of traction in saving the head of the femur from destruction. If an indication for surgical treatment is ever clearly written in pathological specimens, certainly that of distraction should never be overlooked. It should always be remembered that in treating hip disease at a certain stage, the object should not be simply rest, or fixation, or protection from jar, but actual distraction, and that traction short of this is inefficient.

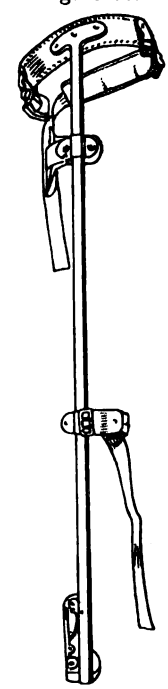
Fig. 1649.



Splint with Curved Pelvic Band.

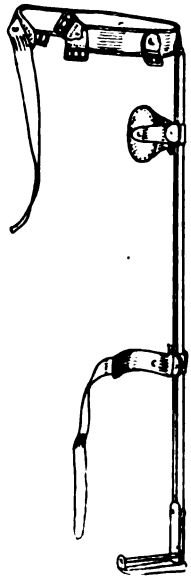
Traction while the patient is going about can be most easily produced by the long traction splint known as the Davis, Sayre, or Taylor splint. The especial form and construction of this splint are matters of very slight consequence provided that its aim be kept

Fig. 1650.



Splint with Straight Pelvic Band.

Fig. 1651.

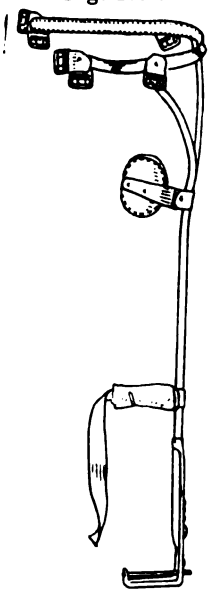


Splint with Straight Pelvic Band.

in mind. The object is to provide a rigid pelvic band which shall serve as a basis for counter extension, made through a perineal band, with a foot-piece placed at the bottom of a shaft running down the leg. To the leg is applied an adhesive-plaster extension apparatus, such as would be used in the Buck bed extension, and this is fastened to a windlass on the foot-piece of the splint. When this windlass is wound up traction is made upon the leg, and if the pelvic band is provided with stout perineal straps, traction comes directly upon the hip joint.

The splint is one which can be made by any blacksmith, and demands no nicety of construction. The forms most commonly used are shown in the annexed illustrations (Figs. 1649 to 1654). The pelvic band should fit tightly to the pelvis, and the upright of the splint may be somewhat curved to conform to the outline of the leg. The perineal bands should pass under the tuberosity of the ischium, and are most conveniently made of leather, or of webbing covered with canton flannel. I have described a cheap hip splint made of gas-pipe,[1] which can be constructed for one or two dollars, and in which traction is made by leather straps attached to the flat foot-piece instead of by the windlass; the splint is fairly efficient, although inferior to any splint in which the windlass is employed. (Fig. 1655.) It need hardly be added that the efficiency of the apparatus depends upon the nicety of its adjustment,

Fig. 1652.

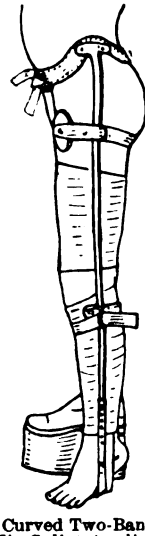


Splint with Open Space over Trochanter.

Fig. 1653.

Straight Two-Band Hip-Splint Applied.

Fig. 1654.



Curved Two-Band Hip-Splint Applied.

[1] Boston Med. and Surg. Journ., March 12, 1891.

Fig. 1655.

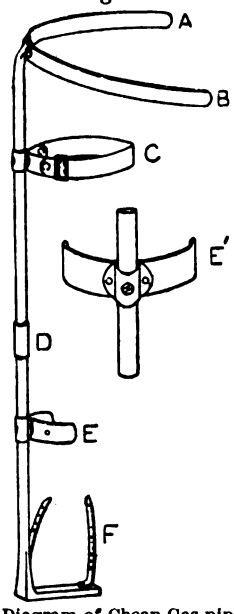
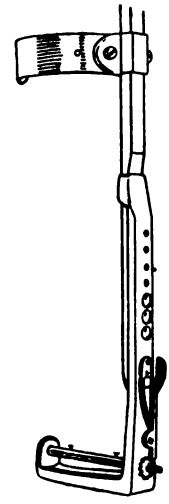


Diagram of Cheap Gas-pipe Hip-Splint.

and upon the care which it receives at the home of the wearer. It is not an apparatus which can be applied and left to the discretion of hospital patients. It must be seen to and adjusted constantly. It should be worn continuously, and the traction should be kept up by constantly winding the windlass as fast as it gets loose. (Fig. 1656.) The patient will experience from this a sense of comfort not to be obtained in any other way, and will be the best judge of the amount of traction to be exerted. In general, however, as much traction as is bearable should be kept up.

The splint does not furnish complete fixation, but is to a certain extent a fixation appliance, and possesses the merit of exerting traction, which to the mind of most American orthopædic surgeons is essential in certain stages of hip disease. The long splint cannot be so adjusted that a patient can walk upon it without modifying the traction at each step, thus producing a jar upon the sensitive joint; consequently it is advisable, if the best results are to be obtained, that the patient should be provided with a high sole upon the well foot, and should walk upon crutches so as to allow the diseased leg to swing, without having even the bottom of the splint touch the ground.

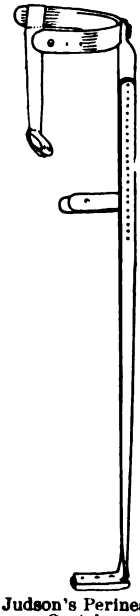
Fig. 1656.



Windlass and Extension as used in Long Traction Splint.

It is also essential as a part of the treatment that the patient should during a part of the day be quiet, preferably upon his back. No diseased hip-joint can be so perfectly protected that the patient can go about with entire impunity, and it is desirable that he should be in bed certainly more than half the time.

Fig. 1657.



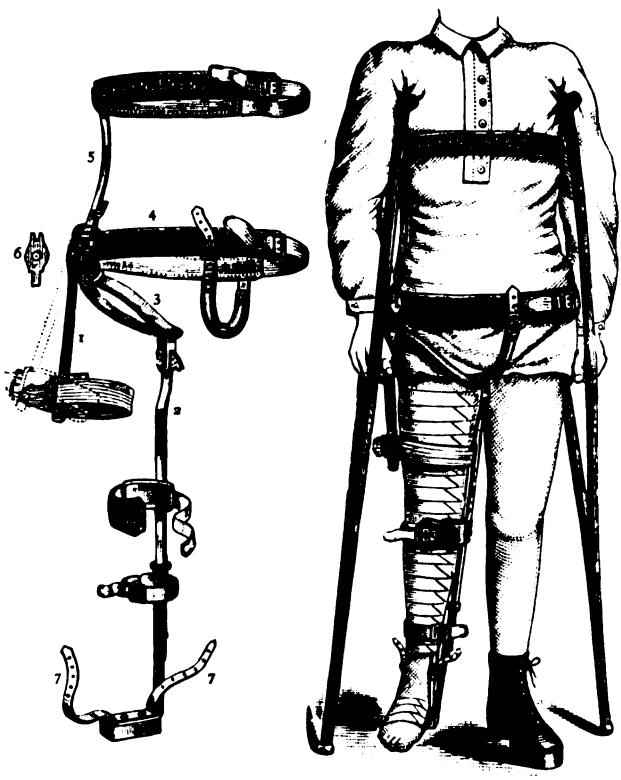
Judson's Perineal Crutch.

Modifications of this splint have been made which exert less traction, such as the perineal crutch of Dr. Judson, which aims at effecting only very slight traction, if any, and is so balanced that the centre of gravity is higher than in the ordinary splint, and walking is easy. (Fig. 1657.) The splint in a modified form is manufactured very cheaply, and is spoken of as the New York Polyclinic splint. To my mind it is deficient, inasmuch as it exerts practically no traction, and should be regarded only as a protection splint.

The splint of Dr. Phelps is perhaps one of the most important modifications of the long traction splint. (Figs. 1658, 1659.) This aims not only at securing better fixation than the common splint, by an arm encircling the thorax, but it also provides theoretically a certain amount of lateral traction in addition to that

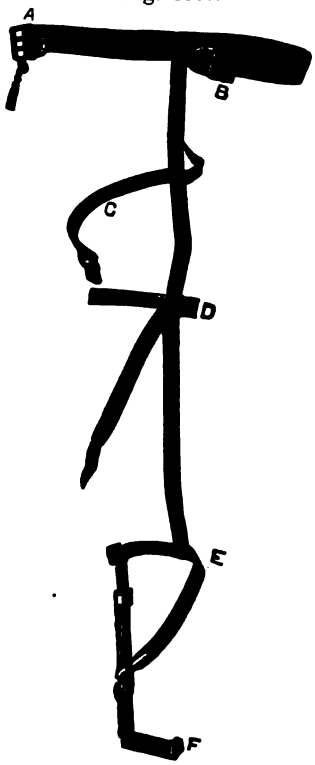
made in the length of the limb. It is doubtful, however, if the splint really exerts much lateral traction, and it probably owes its chief efficiency to the fact that it provides better fixation than the simple Davis-Taylor splint. The question of the value of lateral traction is one which is still unsettled. Dr. Phelps attaches very much importance to it, and uses it as a routine mode of treatment. It has not as yet been largely adopted, and it remains for the future to decide whether it shall form part of the habitual treatment of hip disease or not. The chief point at stake seems to be the employment of strong and persistent traction to separate the joint-surfaces.

Fig. 1658. Fig. 1659.



Phelps's Hip Splint. Fig. 1658 represents the perineal crutch with the abduction bar (1) adjustable by means of the key (6), for the purpose of making lateral extension. The steel bar (2) is adjusted to the steel ring (3), which makes a firm crutch, the pressure coming on the tuberosity of the ischium. Adhesive straps extending to near the body from the ankle furnish means of extension by tightly buckling them to the straps (7, 7), the ring (3) furnishing counter-extension. The rod (5) ending in the upper ring prevents flexion and extension of the legs. The whole splint is intended to prevent every motion at the hip-joint, and at the same time apply extension in a line with the neck of the bone. Fig. 1659 shows the crutch and splint adjusted, the patient using crutches, and standing on a high shoe upon the well leg.

Fig. 1660.



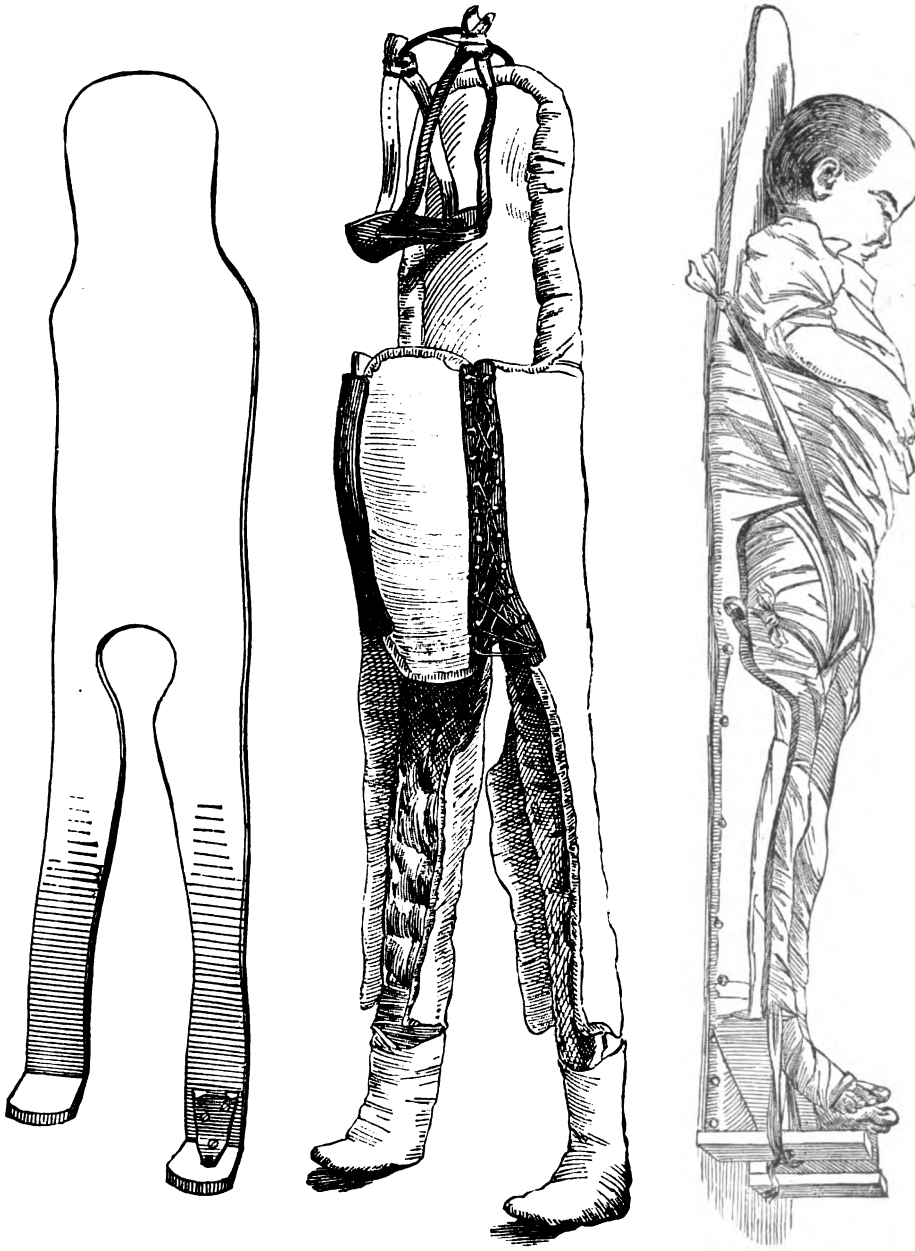
Lovett's Long Splint.

Another modification of the long traction splint, with the purpose of furnishing better fixation, is that shown in Fig. 1660, in which I have made an attempt to combine the Thomas and the Taylor splint, and which has as its object to furnish better fixation to the diseased joint while still exerting traction. It is suitable for use chiefly in hospital practice, in the case of unruly children who cannot be controlled by their parents. Certain more elaborate modifications of the long traction splint have been made, but have not secured general acceptance.

In Germany no one method of treatment meets with general adoption. Fixation splints have been employed by some surgeons, but the tendency in the last few years has been strongly in the direction of the adoption of some form of traction treatment.

Another important modification, described by Dr. Phelps, is a fixation bed, made partly of plaster-of-Paris, being practically a modification of

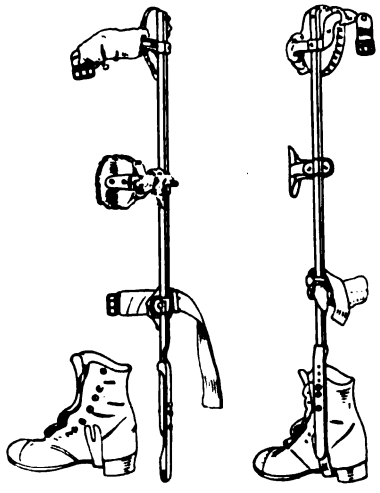
Fig. 1661. Fig. 1662. Fig. 1663.



Phelps's Fixation Bed.

the wire cuirass to which the addition of traction has been made. It provides complete fixation for the patient, who can be carried about, as on a frame, without any jar to the hip; and it is easy to see that the apparatus in spite of its clumsiness may serve a very useful purpose in many cases. (Figs. 1661–1663.)

Fig. 1664. Fig. 1665.

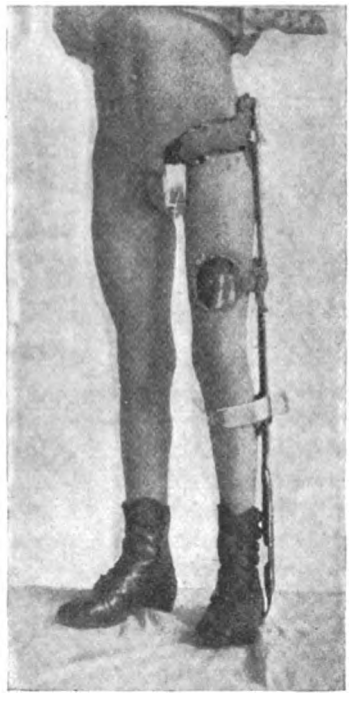


Convalescent Splint.

Where traction treatment is to be adopted, it should in most cases be continued over a period of some years. Traction and rest to the joint should be secured until a time has been reached when muscular spasm and articular pain have been absent for many weeks or months, and then the joint should be further protected for at least two years in ordinary cases. The danger of a relapse is an important one, and is always to be guarded against.

The splint spoken of in American textbooks as the Dowse splint, is the long traction splint merely fastened to the shoe instead of projecting below the foot. It is of such a length that it acts as a perineal crutch, and lifts the heel out of the boot, preventing thereby the impact of the foot in walking. The theory of the splint has been very carefully worked out by Dr. Brackett,[1] who has demonstrated that the foot, and consequently the hip, are protected by it from pressure except at the last part of the step, when the foot is in the act of leaving the ground, and when the least pressure is required. This splint serves to receive the weight of the body in walking, serving as perineal crutch. In a this way the jar does not come upon the convalescing joint, but upon the splint. (Figs. 1664–1666.)

Fig. 1666.



Convalescent Splint Applied.

The frequency and danger of relapse make it advisable that the use of this splint should form a regular part of the traction treatment of hip disease, and that the diseased joint should be thus protected for at least one or two years after the cessation of active symptoms.

Abscesses in Hip Disease.—In spite of much discussion and a certain amount of dissension on the part of men whose opinion carries much weight, such as Shaffer and Judson, it is generally accepted that the proper treatment for the abscesses of hip disease consists in early incision and evacuation of the contents. It is permissible to

[1] Boston Med. and Surg. Journal, Oct. 6, 1887.

sew these abscesses up after a thorough clearing out, without drainage, and in a certain number of cases primary union may be secured.[1] A large proportion of abscesses treated in this way ultimately break down again, but some of them remain permanently healed. On the whole, however, it seems better to pack the wound or close it loosely, allowing the cavity to drain, and the spontaneous closure of the sinus is one of the most favorable of prognostic signs. It is important, in operating upon a hip abscess, to lay open, as far as practicable, the whole extent of the cavity. If possible, the joint should be explored, as its capsule must necessarily have burst, and if a sequestrum is found it should be removed.

The Prevention of Hip Abscesses.—This is a still more important question than that of the treatment of hip abscesses, because it has received very little attention. Mr. Howard Marsh said, in speaking of his cases: "My own estimate, from what I have seen in the hospital and elsewhere, is that the formation of an abscess may be averted in at least 80 per cent. of the total number of cases." In the earlier series of cases reported, however, 60 or 70 per cent. developed abscesses. (Gibney, and London Clinical Society.)

In contrast to these cases a series reported from the Boston Children's Hospital is of much interest; in 320 cases under ambulatory treatment only 23 per cent. developed abscesses. In a later series of cases from the same institution, only 18.7 per cent. developed abscesses in 574 new cases treated by ambulatory measures. The reason for this small percentage is probably the fact that patients under ambulatory treatment are at once admitted to the hospital whenever sensitiveness or deformity of the joint occurs, and are treated by recumbency. Treatment by aspiration and the injection of iodoform, and the like, is in general unsatisfactory, in comparison with free incision.

MALUM COXÆ SENILE.—The form of disease of the hip occurring in elderly persons has generally been regarded as an intractable form of rheumatoid arthritis. The extension of mechanical methods of treatment in all departments of joint surgery, has served to show that much may be accomplished by mechanical support when pain and irritability are present in this condition. H. L. Taylor,[2] in an admirable paper, has related several cases where rest to the joint was afforded by recumbency and traction. After a period of such treatment, a splint similar to that used in convalescence from hip disease was applied, and after a rather long period of such treatment extremely favorable results were obtained. The irritability in these joints seems to yield as readily to rest and traction as do similar symptoms in tubercular disease of the hip.

CONGENITAL DISLOCATION OF THE HIP.—Any article on diseases of the joints would be incomplete without some mention of the recent advances made in the treatment of that most serious affection of the hip joint, congenital dislocation. Information upon its etiology and pathology can be found elsewhere, but the advance in treatment within late years is so promising that the importance of the subject demands a description of the newer methods.

[1] Boston Med. and Surg. Journal, Sept. 18, 1890.
[2] New York Med. Journal, Dec. 15, 1888.

Treatment by Traction.—The early methods of treatment by continuous extension, either in bed or by means of apparatus worn while the patient was walking about, had been practically abandoned until the case reported by Buckminster Brown,[1] of Boston, in 1885. In this case a girl four years old with double congenital dislocation of the hip had very loose joints, the walk was bad, and no trace of an acetabulum could be found by manipulation. The patient was put to bed, and continuous traction was made by weights to stretch the contracted tissues, and to bring the femur into its proper position. After some weeks, passive movements were made by changing the position of the pulleys. The child was kept recumbent for thirteen months, and after two years and three months of treatment, either in bed or by going about in a wheel-crutch, the heads of the femora were found in place on Nélaton's line, and the patient was allowed to begin walking about. At the time of Dr. Brown's report the walk was normal, and she was able to play and run about like other children. It has since been reported that a relapse finally occurred. Only under the most exceptional circumstances, and with parents of exceptional intelligence and interest, could any such treatment be pursued satisfactorily.

Other methods of treatment by traction have not as a rule yielded good results, though Myers quotes from Schede four complete cures effected by means of a splint which held the leg constantly abducted; and the large number of corsets and pelvic bands which have been advocated to retain the head of the femur in its proper position are for the most part worthless, or of very little use,[2] so that on the whole it may be said that the results of mechanical treatment for congenital dislocation of the hip have been of an unsatisfactory character.

Operative treatment was employed very early, even in the time of Guérin, who practised tenotomy of the peri-trochanteric muscles with comparatively little relief. Subcutaneous operations, with or without extension, were performed by Bouvier, Pravaz, Corridge, and Brodhurst. Barwell revived the old operation of Guérin, and reported good results. Koenig and Hueter attempted elaborate operations for covering the head of the femur with periosteum detached from the ilium, but no one operation met with any extended acceptance.

The results of excision have not on the whole been satisfactory. In the first place a stiff joint is likely to result from the procedure; in the second place a certain amount of shortening is necessitated. It is not worth while to enter upon the details of these operations, which have not realized the expectations which had been formed of them.[3]

Of 27 cases which I have analyzed of reported resection for congenital dislocation of the hip, 17 were unilateral, 7 were bilateral, and in 3 this point was not mentioned. In the 7 cases of double dislocation 3 patients walked badly after operation; 4 walked passably, requiring the use of a cane, while in 3 cases it was noted that displacement of the femur during walking persisted. In the 17 unilateral cases operated

[1] Boston Med. and Surg. Journal, 1885, No. 23.

[2] Lehrbuch d. spec. Chirurgie, 1887, Bd. iii., S. 287. Archiv f. klin. Chirurgie, 1885, Bd. xxxii., S. 516.

[3] Jules Guérin, Recherches sur les Luxations Congénitales, 1841. Leçons Cliniques sur les Maladies de l'Apparatus Locomoteur, Paris, 1885. Giraldès, L'Union Méd., 1869. Lecture on Orthopædic Surgery, London, 1876. Lancet, 1885, vol. i., p. 271. A. Mayer, Das neue Heilverfahr. bei Fötalluxationen durch Osteotomie, Würzburg, 1885. Brit. Med. Journal, May 28, 1887.

upon, 1 patient was able to walk all day without fatigue; 2 could walk for an hour or two; 5 walked better than before the operation; 2 were obliged to use crutches; 6 limped; while 1 walked worse than before, and 1 was not reported upon. These might be classed as 3 good results, 5 moderate results, and 8 bad results. It, therefore, seems safe to say with regard to resection of the femur as a curative measure in congenital dislocation of the hip, that its results are unsatisfactory.[1]

Hoffa's Operation.—A possibility for the relief of this condition is held out by the operation of Hoffa, which bids fair to yield better results than any other method of treatment. The operation aims to replace the head of the femur in a socket artificially made by scooping out a hollow in the bone. A free incision is made as if for excision of the hip by the posterior curved line; the cut is carried down until the posterior aspect of the joint is exposed; the capsule is extirpated as far as it offers any resistance; the soft parts and ligaments which prevent the femur from being pulled down are cut, and with a heavy Volkmann spoon the acetabulum is made at the proper place by hollowing out a receptacle in the ilium. The head of the femur is placed in this hollow, and the wound is closed.

The operation is most suitably performed upon young children, under six. In older children the contraction of the parts about the hip is so great that it is difficult in many instances to reduce the dislocation. In some instances Hoffa performed tenotomy of the hamstring tendons and of the fascia about the ilium. He advises against the operation in children over ten years of age. Of 75 patients operated on by Hoffa all who recovered were "greatly improved by the operation." If suppuration occurs, or if the acetabulum is not made sufficiently broad and deep, anchylosis is apt to take place. The first dressing should be kept on for three or four weeks, but after five weeks the child is allowed to walk in apparatus which allows motion at the hip, and which, in unilateral cases, should be worn for several weeks or even months.

Lorenz's modification of Hoffa's operation requires an anterior incision, made below the anterior superior iliac spine. The capsule is very easily reached in this way, and the contraction is more effectively attacked from the front, because the chief obstacle to reduction seems, as demonstrated by Bradford,[2] to lie in the ilio-femoral bands of the capsule. The attachment of the Y ligament should be thoroughly divided near the inter-trochanteric line of the femur. It is possible that by this operation older patients may be operated on and with better success than by the original method of Hoffa.

Lorenz[3] has further modified his operation by making a transverse incision directly outward from the longitudinal incision, in order to afford still easier access to the acetabulum.

[1] Klinik der Gelenkkrankheiten, 1870. Lehrbuch d. spec. Chirurgie, 1889, Bd. iii. Centralblatt f. Chirurgie, 1887, S. 336. Quoted by Kronlein (Deutsche Chirurgie). Centralblatt f. Chirurgie, 1884, No. 14. Archivio di Ortopedia, Anno i., fasc. 5, 6. Archiv f. klin. Chirurgie, Bd. xxx., S. 666. Centralblatt f. Chirurgie, 1884, No. 45. Berliner klin. Wochenschrift, 1887, No. xiv., S. 398. Quoted by Teufel, Deutsche Zeitsch. f. Chirurgie, Bd. xxix., S. 343. Giornale della R. Accad. di Med. di Torino, fasc. 6, 7, 1885. Archivio di Ortopedia, t. ii., Nos. 3, 4, 5. Quoted by Hoffa, Revue d'Orthopédie, Mars, 1891. p. 101. Centralblatt f. Chirurgie, 1887, S. 336. Quoted by Porto, Les Luxations Congénitales de la Hanche, etc., Paris, 1887. Quoted by Hoffa, loc. cit. Ogston, Annals of Surgery, vol. viii., p. 1. Brit. Med. Journal, 1885.

[2] Trans. Am. Orthopædic Association, vol. vii., p. 95.

[3] Ibid., p. 112.

Myers[1] reports 177 cases of Hoffa's operation and its modifications, among which are 6 of death which may have been due directly to the operation, making a mortality of 3.3 per cent.

Up to the end of August, 1894, Lorenz had operated upon 99 cases of congenital dislocation of the hip-joint without a single failure. At the 66th Assembly of German Naturalists and Physicians, in Vienna, he presented no less than 34 children upon whom he had operated. He says: "Scarcely a trace of limping was noticeable, and the patients walked gracefully and exhibited excellent form of body. The children marched erect and with an almost military step, amidst the outbursts of applause on the part of the illustrious assembly of surgeons."[2]

The experience of American surgeons has not been so favorable as that of Lorenz and Hoffa. Many of the operations have been unsuccessful, although done with care and by skilful operators. It has often been found difficult to reduce the dislocation; stiff joints and relapses have at times occurred; and in general the attitude among American orthopædic surgeons is one to a certain extent of indecision. A very fair statement of the feeling is made by Myers, who agrees with the conclusions of Redard, that after the bloody reposition the number of perfect cures is very small; the number of cases improved is large; the results in double dislocation are not so favorable as those in single; and the limp almost always persists in some degree.

In general, the present feeling in regard to the treatment of congenital dislocation of the hip may, I believe, be stated as follows: That traction treatment has been to a large extent a failure; that methods of operation by excision, etc., have not yielded good results; and lastly, that Hoffa's operation or some modification of it offers the best chance of relief. In these cases the success of the operation will depend largely upon the age of the child and the anatomical conditions peculiar to the individual case. The parents of the child cannot be assured that the operation will be a success, but they may be told that it is not likely to make the child any worse, and that it is attended by very slight risk to life.

DISEASES OF THE KNEE-JOINT.—The affection known as tumor albus and formerly classed as strumous, scrofulous, or fungous synovitis is the most frequent of all diseases of the knee-joint. It is now recognized as a tuberculous affection, sometimes beginning in the bone and sometimes in the synovial membrane. The following table, from Willemer, shows the frequency with which each structure is attacked:[3]

	Primarily synovial.	Primarily osseous.
Under 10 years,	39	61
From 10 to 20 "	49	51
Above 20 "	33	65

König reached similar results in analyzing 114 museum specimens, 69 being osseous in origin, 33 synovial, and 12 doubtful.

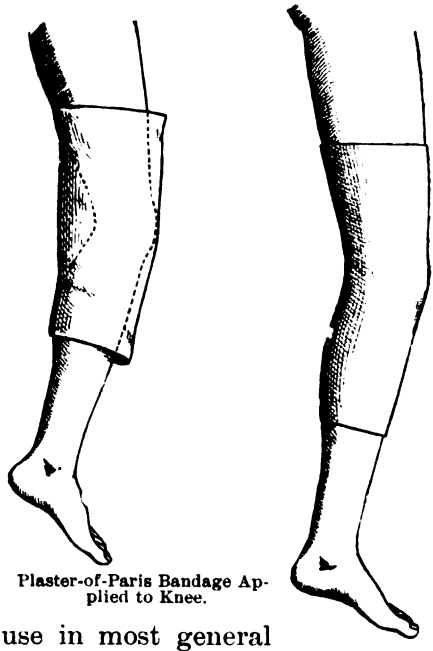
It seems probable from these statistics and others[4] that in youth the disease begins in the synovial membrane in about half of the cases, while the others are of osseous origin—whereas later in life the osseous forms predominate much in frequency.

[1] Transactions Am. Orthopædic Association., vol. vii.
[2] Ibid., p. 104.
[3] Willemer, Deutsch. Zeits. f. Chirurgie, Bd. xxii., S. 268.
[4] Cheyne, Brit. Med. Journal, April 4, 1891.

In practice one can generally distinguish between the two forms, for in the one case a synovial distention passes slowly or rapidly into a fungous enlargement, whereas in the cases of bony origin enlargement of the bone, pain, and muscular spasm precede any synovial effusion. Nowhere can the traumatic origin of tubercular joint disease be more clearly demonstrated than in these cases of beginning tumor albus.

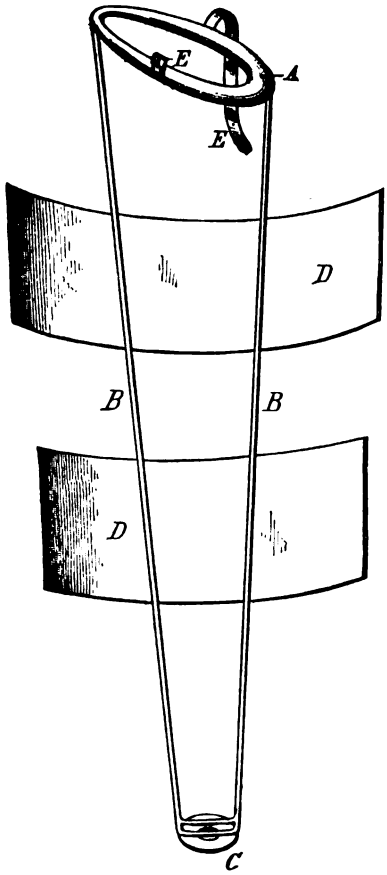
Treatment.—The treatment of tumor albus originated by Thomas and advocated by Barwell, is the one in most common use in American orthopædic practice. Partial fixation can be obtained by means of plaster-of-Paris, leather, silicate, or dextrin bandages applied to the leg, and these are the methods in use in most general hospitals (Fig. 1667). But they are not suitable for continued use, as they loosen and become dirty, and they furnish incomplete fixation, no matter how carefully they may be applied. Dr. Judson says with regard to them: "It may be an exaggeration, but it conveys the idea, to say that a plaster-of-Paris or silicate splint, applied to the leg and thigh, contains a mass of jelly in which the femur is but little restrained from motion." In addition to this, *unless the patient has a high sole upon the other boot and uses crutches for an indefinite period, the joint is not protected from weight-bearing in walking*, and this is a matter of prime importance in tumor albus. So that if the stiff bandage is adopted it must be for an indefinitely long time, and the patient should not bear his weight upon the limb.

Fig. 1667.



Plaster-of-Paris Bandage Applied to Knee.

Fig. 1668.



Thomas Knee-Splint.

The Thomas knee-splint (Fig. 1668) is a ring of iron fastened at an angle of 45 degrees to two uprights which project below the foot. This ring of iron is padded and fits closely the upper part of the thigh, so that in walking the patient receives perineal support, practically sitting in this ring and bearing no weight

upon the knee. As used at the Boston Children's Hospital this splint is slightly modified, as shown in Fig. 1669. It is provided with accurately fitting leather lacings for the thigh and the calf of the leg, furnishing excellent fixation, and in addition to this a bar is provided at the bottom of the splint around which a sticking-plaster extension band may be buckled so as to make traction upon the knee in cases attended by much irritation. A high shoe is placed upon the other foot, and the patient is able to go about during the whole course of the disease unless this is too acute or unless the knee is flexed.

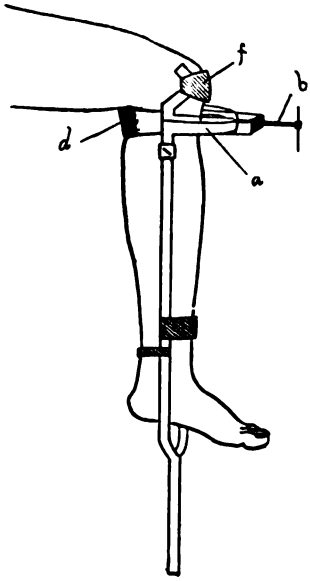
Fig. 1669.

Modified Thomas Knee-Splint.

If there is much flexion from muscular spasm the Thomas splint becomes unwieldy, because it is difficult to fix the flexed leg by a straight apparatus, and because traction cannot be made in the line of the deformity, while if made otherwise it becomes painful and irritates the knee. Under these circumstances various plans may be adopted:—

(1) The knee may be straightened while the patient is under the effect of ether by the use of more or less force, and a fixed dressing, as of plaster-of-Paris, may be applied while the limb is in the straight position. This plan is only to be used in cases of moderately long standing, because, of course, if anchylosis has occurred some more radical operation is required.

Fig. 1670.



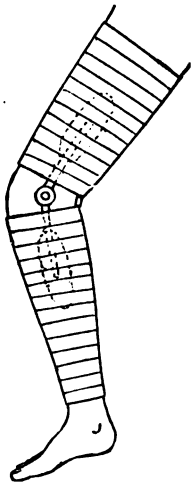
Goldthwait's Apparatus for Forcibly Straightening the Knee.

(2) By a succession of plaster bandages, applied at intervals of a week or ten days to the flexed limb in its deformed position, the irritation may be quieted, and at each application the knee will be found in a straighter position, without the use of force; this method is to be pursued until the leg is straight.

(3) In cases where fibrous anchylosis has occurred in a flexed position the apparatus of Goldthwait[1] (Fig. 1670) is of much use for forcible correction. It is always employed with the patient under ether. After the ad-

[1] Boston Med. and Surg. Journal, Sept. 7, 1890, and Dec. 1, 1892.

Fig. 1671.



Billroth's Knee-Splint.

hesions have been broken up as much as possible with the hands, the apparatus is applied with the leg flexed. The posterior band (*d*) is then screwed forward, and the leg straightened intermittently, by the use of the long lever. A dressing of plaster-of-Paris is afterward applied. This apparatus not only straightens the leg, but tends to correct the subluxation of the tibia as well.

(4) An apparatus known as the Billroth splint is used at the Hospital for the Ruptured and Crippled, in New York, to straighten these limbs by gradual and gentle force, without the use of ether. A plaster bandage is applied to the limb, and in this bandage are incorporated two hinges attached to broad curved iron plates. These hinges are placed over the lateral aspects of the joint, allowing anterior-posterior motion. The bandage is allowed to harden, and then a circular division of the plaster is made at the level of the knee, and the front of the bandage over the knee is cut away. Into the transverse slit at the back of the knee are inserted wedges of increasing size, until the limb is straight. The splint exercises considerable pressure. (Fig. 1671.)

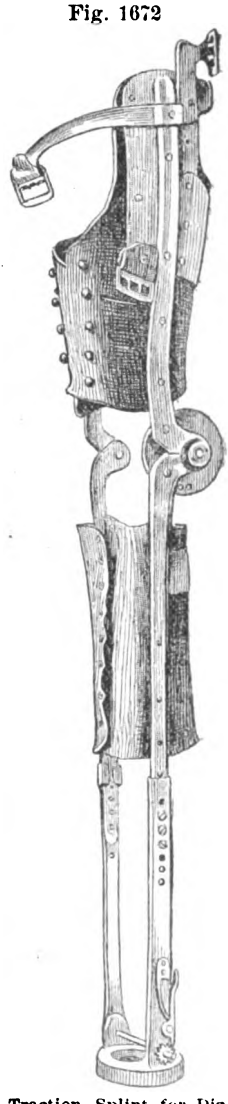
The Thomas knee-splint has been advocated as a means of straightening the knee by fixing the thigh and pulling the leg forward by bandages passing behind the calf. In my own hands it has proved more often a source of irritation to the knee than a means of cure.

(5) Correction of flexion during the acute stage by traction made in the line of deformity is by far the most satisfactory method, as well as the safest; and the splint which is used for this purpose is, to my mind, by far the best apparatus for routine employment in tumor albus.

It provides three things—protection from weight-bearing, fixation of the diseased joint, and traction in any desired line. In principle it is practically like the long traction splint jointed at the knee. From Fig. 1672 it can be seen to consist of a pelvic band, an outside upright jointed at the knee, and a traction foot-piece; an inside upright reaches from the foot-piece nearly to the adductor tendons, but is not essential, and is used merely to steady and strengthen the apparatus.

The disc at the knee-joint in the outer upright is perforated with screw-holes, so that the splint may form any desired fixed angle at the knee. Leather lacings fix the thigh and calf of the leg. Sticking-plaster extension bands, attached below the knee, pull downward by winding the windlass, while plas-

Fig. 1672



Traction Splint for Disease of the Knee-Joint.

ter counter-extension bands, attached to the thigh, pull upward and are buckled to the outside and inside uprights, the straps passing through the thigh lacing. In addition to this extending plaster pulling upward on the thigh, counter-extension to the downward pull is furnished by the perineal band in the groin, which also protects the leg from weight-bearing in walking, being, just as the hip splint is, a perineal crutch. The splint is applied, adjusted at any angle that suits the diseased limb, and the perineal band is then strapped and the upward thigh extension buckled. Then the straps from the calf extension plaster are passed around the windlass and tightened. This pulls directly upon the knee-joint, tending to distract the joint surfaces. Then the leather lacings are tightened, serving to prevent motion at the knee, which is being pulled upon in the line of deformity, and all the time, except in the severest cases, the patient may go about freely walking upon the bottom of the splint.

The splint is rather complex, and therefore expensive, but it can be made by almost any machinist if the surgeon knows just what is wanted, and is in every way the best and most useful splint for the purpose.

Excision of the knee is to be regarded as a mode of treatment inferior to the mechanical methods just mentioned, or as a treatment to be adopted when mechanical measures have failed, or are not likely to be of use on account of the advanced stage of the disease.

The operation necessarily entails a loss of bony substance, and shortening, and in the case of young children the injury to the epiphysis may be a very important matter in causing serious injury to the growth of the limb.[1] Mechanical treatment on the other hand in suitable cases produces excellent results, in the milder cases often restoring perfect motion. In most cases which are under control and not advanced when the treatment is begun, mechanical measures suffice to cure the disease. This remark of course applies chiefly to children, for in the case of adults tuberculous disease of bone offers a less favorable outlook than in childhood. Considering then excision as a mode of treatment to be adopted only in advanced cases, and where mechanical treatment has failed, the question of the mortality rate of the operation becomes of the first importance. The advent of antiseptic surgery has produced a most striking change in this matter. Ollier's[2] mortality fell from 80 to 14 per cent. after antiseptic precautions were adopted. Meusing[3] found in 80 cases that:—

1. Before antiseptic surgery the mortality was 33 per cent.
2. After antiseptic surgery was introduced the mortality was 8.5 per cent.
3. After the introduction of permanent dressings the mortality was 2 per cent.

Phelps gives the mortality in 329 cases treated antiseptically as 9.42 per cent.[4]

The latest statistics with regard to resection of the knee may perhaps be quoted from Lossen.[5] Of 586 patients who had had resection of the

[1] Hoffa, Archiv f. klin. Chirurgie, Bd. xxxii., S. 4.
[2] Revue de Chirurgie, 1884, p. 157.
[3] Centralblatt f. Chirurgie, 1883, No. 49.
[4] Phelps, Trans. N. Y. State Med. Society, 1886, p. 586.
[5] Deutsche Chirurgie, Lief. 29, b.

knee for tuberculosis and its results, observed during hospital treatment only—

439	or	74.9	per cent	were	healed.
59	"	10.1	"	"	unhealed.
50	"	8.5	"	"	amputated.
38	"	6.5	"	"	dead.

Of 384 patients observed from one to fourteen years after resection—

274	or	71.3	per cent	were	permanently healed.
46	"	12	"	"	showed sinuses.
18	"	4.7	"	"	were unhealed.
10	"	2.6	"	"	amputated.
36	"	9.4	"	"	dead.

It seems hardly worth while to quote in full the very large number of statistics given on this subject, and the more recent references therefore only are given.[1] It is evident that the mortality rate is a low one (3–10 per cent.), that the results of the operation are more satisfactory than in the hip, and that it is a proceeding to be undertaken without hesitation when necessary. Excision of the knee is, I believe, indicated (*a*) when the disease is advanced to a stage when sinuses of long standing are present, and the joint is thickened, hot, and tender; (*b*) when in spite of careful mechanical treatment the disease has progressed unfavorably, and flexion and sensitiveness of the joint cannot be controlled; (*c*) in cases of moderate severity when mechanical treatment cannot be obtained; and (*d*) in cases of cured disease where anchylosis in a position of right-angled flexion is present.

In the acute stages of the disease the operation is much less likely to be of use in the case of adults, and amputation is often to be preferred; but this is a matter which must be decided in the individual case rather than by rule, and belongs to the domain of general surgery.

Arthrectomy or erasion of the knee-joint has been advocated as a substitute for excision by many surgeons of distinction. Arthrotomy is a term used to describe the same procedure, but the former name is the correct one. Synovectomy is another name occasionally employed.

The operation consists in opening the joint freely by a semilunar incision, as if for a resection. The joint capsule is cut away in front of the joint, and all pulpy granulation tissue is removed by the scissors and forceps, or by the curette; diseased foci in the bone are gouged out, and in doing this, especially at the back of the joint, much care is necessary. The infiltrated capsule and semilunar cartilages are removed, and every effort must be used to leave none but sound tissue. In accomplishing this the application of the Paquelin cautery is often useful. Various modifications in the operative technique have been suggested, but the essentials of the procedure are as above given. The operation, it is easy to see, is not suited to advanced cases, and is most likely to be of use in those of primary synovial tuberculosis, which are not as common as the osseous. If the surgeon believes, as I do, that mechanical treatment is sufficient to cure most cases, and should be persisted in until it is manifestly inadequate, he will see that it will then commonly be

[1] Ollier, Sur la Résection du Genou, Bull. de l'Acad. de Médecine, No. 20, 1889. Hitzegrad, Mitt. aus der chirurg. Klinik zu Kiel, Bd. iv; Zoege-Manteuffel, Deutsche Zeitschrift f. Chirurgie, Bd. xxix., S. 113. Neugebauer (101 resections of Lücke's), ibid., Bd. xxix., S. 4. Boeckel (140 cases), La Semaine Médicale, 12 Avril, 1892. Cristovitch, Bull. gén. de Thérapeutique, Paris, 15 Avril, 1892.

too late to perform arthrectomy, and that excision will be the only operation to consider. Arthrectomy then will find a place chiefly with those who favor early operative treatment,[1] either because they have not apparatus at their command, or because they prefer operative to slower measures. If arthrectomy be done early, perfect motion may be obtained in the affected joint, and the results of the operation are in general reported as satisfactory: the wound closes early, the mortality rate is low, and there is not the shortening which is likely to accompany complete resection.

Senn analyzes 70 cases of arthrectomy for knee-joint disease collected from various sources. Of these 7 proved fatal, the causes of death being as follows: pulmonary tuberculosis 2, iodoform poisoning 1, chloroform 1, general tuberculosis 1, tubercular meningitis 1, and tubercular peritonitis 1. Nineteen times the operation was a failure, and was followed by return of the disease. Forty-four times the operation was successful, and in none of these cases did any shortening of the limb occur. A movable joint was noted in 8 cases, and a fixed joint in 32; in no case did a flail joint occur. Contraction of the joint into a flexed position occurs in certain cases when the splints are removed too early.

With regard to amputation for knee-joint disease, it only remains to be said that it is a measure occasionally necessitated in children by a relapse after excision or arthrectomy, and that in adults it is frequently to be considered as a primary measure in cases of extensive disease, inasmuch as excision is in these cases often unsatisfactory.

ANKLE-JOINT DISEASE.—Tubercular disease of the ankle and tarsus is an affection fairly common in childhood, but fortunately more rare in later life. The location of the disease is most frequent in those bones which seem to transmit the body weight, viz., the os calcis and the astragalus. It is believed by most authors that the disease is generally of primarily synovial origin. Münch, for example, found in 28 cases that the disease was primarily synovial in 23, while in the other 5 cases the focus was once situated in the tibia and four times in the astragalus. Erasmus, however, differed from the general opinion in finding that of 11 cases only 2 were primarily synovial.

As to the individual bones affected, Czerny found that in 52 cases the astragalus was affected 15 times, the os calcis 13 times, the cuboid 16 times, and the scaphoid and cuneiform 8 times. Often the lower end of the tibia is affected while there is a focus in the head of the astragalus, but the complex arrangement of the synovial membrane at the ankle makes extension of the disease very easy to other bones and other parts of the articulation from that originally affected, and the same condition renders complete removal of the diseased tissues very difficult.

The symptoms of disease of the ankle-joint, in addition to the swelling, have been very slightly alluded to, and are of much importance in connection with the diagnosis. A persistent swelling about either malleolus is exceedingly suspicious; any thickening over the front of the ankle-joint points to an inflammation of the synovial membrane; while swelling and tenderness over the os calcis indicate probable dis-

[1] Volkmann, Centralblatt f. Chirurgie, 1885, No. 9. Mandry, Beitr. zur klin. Chirurgie (Bruns), Bd. iii, H. 2, 1887. Israel, Berliner klin. Wochenschrift, 1889, No. 5. Zesas, Centralblatt f. Chirurgie, 1886, No. 28. Duncan, Amer. Journ. Med. Sciences, April, 1889, p. 369.

ease of that bone. Along with the swelling and the inflammation of the joint is associated stiffness of the joint movements. This is apt to be deceptive, because at times the medio-tarsal joint becomes more than normally flexible, and executes a certain amount of the movement ordinarily accomplished at the ankle-joint itself. This tends, unless the surgeon is carefully on the watch, to mask the rigidity of that articulation.

There are two malpositions which are not commonly found in cases of ankle-joint disease and which have been but slightly alluded to. One is a distinct talipes equinus with the foot held rigidly in that position. In connection with this there is generally swelling of the ankle, to show that it is not an ordinary talipes equinus. The same may be said of talipes calcaneus, which occasionally, although more rarely, exists in connection with ankle-joint disease. The foot is sharply flexed and held in that position by muscular spasm. Pain is generally a prominent factor, but is not always noticeably present, so that the significance of these two malpositions may be overlooked. They are evidences of muscular irritation, and are of the same class of symptoms as the malposition of the hip in early joint disease, and the flexion of the knee in early tumor albus.

To speak for a moment of tarsal and metatarsal disease, it is distinguished chiefly from ankle-joint disease by the fact that in the former the ankle-joint is movable, and that the swelling is chiefly localized to the tarsal region, or to some especial metatarsal bone.

Swelling of the metatarsus involves ankle-joint movement if it goes on to any marked degree, although it is never severe enough to cause the malposition spoken of in connection with ankle-joint disease proper. It is in young children chiefly that metatarsal disease occurs, and the bone most frequently affected is the first metatarsal. The process seems more like a periostitis than a true osteomyelitis, and very frequently on incising these swellings a partial necrosis is found.

With regard to the treatment of ankle-joint disease, I incline very strongly toward the expectant method, not only in children but also in mild cases in adults. In pursuing this treatment the error is very often made, just as it is in disease of the knee-joint, of fixing the diseased joint in plaster of Paris, and allowing the patient to walk about, without perhaps even the use of crutches. This, of course, furnishes fixation to the joint as far as hinge motion goes, but it affords no protection whatever against the jar of the body weight in walking, and consequently is very incomplete, and insufficient to protect the joint from becoming worse. Fixation, even if enough to prevent motion, is only half the treatment, and should be joined to protection against weight-bearing in all cases severe enough to require any treatment at all.

The method to be pursued in these cases is a very simple one, and has yielded the most satisfactory results. The child's foot is done up in a small and light plaster-of-Paris bandage reaching from the toes to just below the knee, or in severe cases even above the knee. This bandage is ordinarily left on for some weeks, although it may be cut down the front and furnished with lacings to be removed just as is a plaster jacket. It is preferable, however, for it to be left on for some weeks at a time, unless in exceptional cases. This fixation splint is

worn in connection with the Thomas knee-splint which has been described.

In speaking of diseases of the knee-joint it was shown that this Thomas knee-splint furnished fixation to the knee, and prevented the child from bearing weight upon the foot in walking. The combination of fixation and protection enables the ankle to be absolutely protected against traumatism, and, except for the unfortunate dependent position of the ankle, it is placed as favorably as possible for recovery. Instead of the plaster-of-Paris fixation bandage, a more comfortable and fully as satisfactory an apparatus is obtained in a small, light fixation shoe, which is practically a skeleton bandage furnishing fixation to the foot by leather lacings. The apparatus consists of a light steel sole-plate fitting the sole of the foot, and two uprights connected with it fitted to the leg, and running to the upper part of the calf, where they are connected posteriorly by a flat curved band. The foot and the leg pieces are furnished with leather lacings, which afford as complete fixation as does a plaster bandage, and the apparatus is cooler and may readily be removed. It also is worn in connection with the Thomas knee-splint. The patients are allowed to go about freely until some months after the swelling and tenderness, and the muscular irritability, have disappeared. Then the use of the splint is gradually discontinued.

Dr. Gibney has made some investigations as to the results in cases of ankle-joint disease treated conservatively.[1] Observations were made upon thirty cases, the average duration of which was three years and three months, with a minimum duration of one year and a maximum of six years. In nineteen cases suppuration was very extensive, while in only five cases of the whole number was it entirely absent, this showing that a severe class of cases was under consideration. When these cases were investigated the limbs were slightly shortened, and the calf was atrophied. Twenty of the patients did not limp at all, and seven only slightly. The remarkable results obtained from this series of cases show that tubercular disease of the ankle belongs to a more benignant class of affections than similar disease of the knee or hip joints; in fact, the results from proper conservative treatment are generally extremely satisfactory, and operative measures are not indicated until mechanical treatment has manifestly failed. If the conservative method fails to give a satisfactory result after a proper trial has been made, three measures remain for consideration. The simplest is curetting the sinuses or removing whatever diseased bone is within reach of the curette. The second operation is a formal excision of the diseased bones, and the third is amputation of the foot or leg, which is occasionally necessary.

With regard to curetting the diseased bone without the performance of a formal excision, the complex nature of the ankle-joint, already alluded to, makes adequate removal of the diseased tissue very difficult. The work is done in the dark, without a knowledge of the situation or extent of the disease, and must necessarily be done blindly, often leaving large masses of unhealthy tissue behind. In certain cases this plan of treatment may affect the disease favorably, but in the majority relapse occurs and requires a more formal and extensive operation.

[1] Med. Record, Aug. 21, 1880, p. 197.

With regard to excision, it may be said that in general the results are extremely satisfactory in young children, and less so in adults.

In eighteen cases analyzed by Dr. C. L. Scudder,[1] six patients died, five from tubercular meningitis and one from shock. The end results in all cases were good when investigation was made years after operation. Most of these cases were at first treated conservatively, and an operation was only employed when it became necessary, so that they represent a trial of conservative methods and of late rather than of early excision. In all but one case the disease was ended by operation. Dr. Scudder thought that the degree of flexion and extension of the ankle-joint was slightly greater in cases successfully treated by excision than in those treated expectantly. No serious deformity occurred in any instance.

Of 108 cases reported by Conner in which excision was resorted to, he found that in 10½ per cent. there was failure. In six per cent. the patients could walk with only a cane, and the remainder were classed as good or perfect results.

These figures are sufficient to show that after a carefully performed excision the result is likely to be excellent, and that the death-rate is a very low one; but none the less I would advocate very strongly the adoption of the conservative plan of treatment, which is capable in most cases of yielding excellent results, and which only occasionally fails to prevent the necessity of excision.

SHOULDER-JOINT DISEASE.—*Chronic sprain* of the shoulder is an affection which has received very little attention, but which is exceedingly frequent, especially in hospital clinics, and which is much benefited by suitable treatment. How often the lesion should be classed as a chronic synovitis cannot be determined: in many cases it seems only a muscular contusion, persisting as a stiffness and irritability of the muscles involved in moving the shoulder joint; in other cases it is clearly a bursitis, or a teno-synovitis of the tendon of the biceps or of some neighboring muscle; at other times it is a simple chronic synovitis of the joint, sometimes made worse by the fact that the patient is the subject of chronic rheumatism. In either of these conditions the history is that after a blow or a fall upon the arm or shoulder, the pain does not subside, but persists for weeks or months. Tenderness is often present over the anterior surface of the joint. Motion is limited, especially in the direction of deltoid movements. Pain may be present, and stiffness to a greater or less degree is uniformly prominent. These may be the symptoms of chronic osteitis, of rheumatoid arthritis, or simply of chronic sprain, and the diagnosis must of course be made with care, although the treatment about to be described is not unsuitable to any one of these conditions.

Assuming then, as is evident from the symptoms, that the condition of the joint is one of irritability, the problem is first to quiet the irritation and then to restore motion to the part. The shoulders should at first be fixed so that motion may be impossible. This is most easily done by the application to the arm of a sling long enough to support the elbow, with a broad swathe embracing both arm and chest to prevent lifting the arm from the side. This combination of the sling

[1] Transactions of American Orthopædic Association, vol. ii.

and the swathe is a firm and efficient bandage. The clothes are put on without disturbing the arm, and counter-irritation is applied to the joint by iodine, blisters, or preferably light scoring with the Paquelin cautery. This is likely to cause the sensitiveness to diminish rapidly. After some days, or two or three weeks, of such fixation, the bandage is removed daily for a few minutes of massage and passive manipulation, and is then at once reapplied. Gradually the time of passive motion is increased, and active motion is substituted, always remembering that the chief danger is of going too fast rather than too slowly, and not allowing rough or painful manipulation. In my hands this plan has yielded the most satisfactory results, much more so than electricity, forcible manipulation, or rough massage.

Tubercular Disease of the shoulder is fortunately not very common, and occurs most often in children. It is not practicable to apply traction satisfactorily on account of the impossibility of obtaining counter-extension in the axilla, because of the vessels and nerves there. Fortunately the weight of the arm in itself furnishes a mild form of traction, and with such fixation as can be furnished by a plaster bandage enveloping the arm, chest, and shoulder, satisfactory results are generally attainable. Excision is to be undertaken when the disease is progressing in spite of a fair trial of expectant measures.

DISEASE OF THE ELBOW-JOINT.—Little need be said that has not already been mentioned in speaking of other joints. Disease is made evident by swelling of the synovial sac with pain and muscular limitation, along with wasting of the arm and forearm. Flexion and perhaps rotation are painful; the arm is held stiffly by the muscles, perhaps at a right angle, but more commonly, and especially in severe cases, somewhat extended. The indications are, just as in similar conditions in the shoulder or the hip, to rest the affected joint, and distraction of the joint surfaces would be desirable could it be obtained. But the apparatus invented for that purpose is so cumbersome as to be useless, and the best substitute is plaster of Paris, or a leather splint, simply preventing motion. Continued fixation by a tin internal angular splint is objectionable on account of the necessity of using sticking-plaster, the irritation attendant upon which is an annoyance. Fixation must be persisted in until joint irritability has ceased, as tested by the subsidence of pain, heat, swelling, and muscular irritability. As in the other joints, fixation may be gradually removed when this condition has become permanent.

Excision is to be deferred in the case of children as long as possible, for often the most surprisingly bad cases will recover under expectant treatment, and the results of elbow-joint excision done in children for tubercular disease are not encouraging. Fortunately the disease is chiefly confined to young adults, where the results of resection are more favorable.

DISEASE OF THE WRIST-JOINT AND CARPUS.—This offers no especial features of interest. The joint is easy to fix, traction is not needed, and a plaster-of-Paris, a leather, or a tin splint is sufficient to fulfil all indications. Excision is necessary in persistent or bad cases.

NOTE.

For permission to use in the preceding Article Figs. 1643, 1644, 1645, 1649, 1650, 1651, 1652, 1653, 1654, 1655, 1656, 1657, 1664, 1665, and 1666, the Author is indebted to the Trustees of the Fiske Prize Fund.

EXCISIONS AND RESECTIONS.

BY

JOHN ASHHURST, JR., M.D.,

BARTON PROFESSOR OF SURGERY AND PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PENNSYLVANIA HOSPITAL, PHILADELPHIA.

SINCE the publication of the article on excisions in the third volume of this work, my personal experience in this particular class of operations has been more than trebled, and I have been led to modify somewhat the conclusions then expressed. Thus as regards the *contra-indications* to excision, I have been encouraged to apply this conservative operation to cases of an *acute character* in which I formerly thought amputation preferable, and I have ventured, in the case of the knee at least, to extend the benefits of this procedure to patients of considerably more advanced *age* than I did in the earlier period of my practice. On the other hand, by the introduction of "arthrectomy," or "erasion," as a mode of treating knee-joint disease, I have found that in selected cases a better limb can be secured than by resection, while by the adoption of Billroth's suggestion to practise intra-articular and interstitial injections of iodoform suspended in glycerine (one part to ten), I have in a few instances, in which I should have formerly thought excision necessary, succeeded in obtaining a cure without resorting to any cutting operation whatever. Observance of the precautions of antiseptic surgery has diminished the immediate risks of excision, and has hastened the healing of the external wound, but on the other hand has, I am satisfied, in some cases delayed bony union (which is wished for after knee-excisions), and has thus compelled the use after recovery of prosthetic apparatus, which otherwise would not have been required. I have in the following pages endeavored to summarize in tabular form the results of my increased experience with excision and resection in the several regions of the body, and venture to hope that the exposition will be of interest to the reader.

UPPER JAW.—To the six cases of complete excision of the upper jaw referred to in the original article, I have added three more, the nine cases having given three deaths, only two of which, however, can be directly attributed to the operation.

But besides these three deaths, it will be observed that in an equal number of cases recurrence of the disease for which the operation was performed took place within three months, so that the ultimate results of the procedure are not very encouraging. In view, however, of the hopeless character of the affections for which excision of the upper jaw

is usually resorted to, and considering the excessive pain and discomfort which they cause, the operation must be considered a justifiable one, even for the temporary relief afforded.

TABLE OF NINE CASES OF EXCISION OF THE UPPER MAXILLA.

No.	Sex, age, and date.	Nature of affection for which operation was required.	Result.	Remarks.
1	Male, 16	Naso-pharyngeal tumor	Died	Episcopal Hospital. Death from shock. Jaw excised as preliminary to removal of growth.
2	Male, 25, 1879	Osteoma of upper jaw	do.	University Hospital. Death from secondary hemorrhage.
3	Female, 50, 1879	Sarcoma of upper jaw	Recovered	University Hospital.
4	Female, 71, 1880	Carcinoma of upper jaw	do.	do.
5	Male, 8, 1886	Sarcoma of upper jaw	do.	do.
6	Male, adult, 1887	do.	do.	Do. Recurrence in 2 months.
7	Female, 50, 1887	do.	Died	Do. Death from renal disease on 12th day.
8	Male, 63, 1889	do.	Recovered	Do. Recurrence in 3 months.
9	Male, 65, 1892	do.	do.	Do. Recurrence in 2 months.

LOWER JAW.—In addition to the cases referred to in Vol. III., I have since successfully excised the middle portion of the lower jaw with a part of the tongue, for epithelioma, and I have twice removed wedge-shaped portions of the bone for contraction of the jaw, according to Esmarch's method. Both cases afforded good results, but in the first the patient suffered much after the operation from pain in the course of the inferior dental nerve, apparently from irritation caused by the saw with which the bone was resected; hence in the second case I took the precaution to expose the nerve first with a trephine and excise a portion, and I would recommend this as a useful modification of the ordinary procedure.

STERNUM.—Linoli's case of excision of a displaced *ensiform cartilage* after laparotomy for uncontrollable vomiting, is mentioned in Vol. III., and the operation has since been repeated by Rinonapoli. Annandale relieved the vomiting in a similar case by replacing without excising the bone, after abdominal section. I have successfully excised the ensiform cartilage *without opening the peritoneum* in a case of intractable neuralgia, for which, from its analogies with the similar condition met with in the coccyx, I would suggest, when the pain is localized in this part, the name *xiphodynia;* the external surface of the peritoneum is necessarily exposed in this operation, but by keeping the knife close to the bone, and exercising great care, it is possible to avoid wounding the serous membrane. Graves has successfully excised the *gladiolus* for sarcoma.

RIBS.—I have in four cases had occasion to employ excision ot one or more ribs—in one case for syphilitic necrosis involving but a single rib, and in three cases for empyema (Estlander's operation), in one instance removing portions of three, and, in the other two, portions of four ribs.

The result in all has been satisfactory, though in one of the cases of empyema the patient is tuberculous, and entire recovery is therefore not to be expected. Contrarily to the ordinarily received view, I have found very little trouble from hemorrhage in excisions of the ribs, the intercostal arteries being commonly occluded as the result of the previously existing disease.

PELVIS.—C. Nélaton records a case in which he removed the whole *ilium*, the patient recovering and preserving the power of walking; partial resection—cutting out a wedge from the crista ilii—has, in my hands, proved of value in the treatment of iliac abscesses, and is, I think, upon the whole preferable to trephining the ilium as advised by Fischer, Riedel, and Gangolphe. Partial excision of the *sacrum* is recommended by Kraske as a means of facilitating operations on the rectum, a purpose accomplished by Heinecke, Rydygier, and Gussenbauer, by means of temporary resection of the same bone.

CLAVICLE.—I have twice had occasion to excise the entire clavicle, once for necrosis and once for tumor—an ossifying enchondroma—and in a third case I removed the inner two-thirds of the bone for a large osteosarcoma, the last-mentioned operation having been the most difficult of the three. In the case of necrosis, the bone was readily peeled out from its periosteal sheath, and quick reproduction took place, the patient regaining the use of his arm in not much longer time than is required for the repair of a fracture of the bone concerned. In all the three cases the patients recovered satisfactorily from the operation, but in the case of sarcoma the growth recurred after some months and led to a fatal result. To the 28 cases of total excision of the clavicle tabulated in Vol. III., page 580, I am now able to add 9 more, viz., the successful cases of Jessett, Krönlein, Sloan, Tansini, Wheeler, and two of my own, the fatal case of Segond, and one of uncertain result in the hands of Després; the whole 37 cases gave 29 known recoveries, one undetermined, and but 7 deaths, a mortality of only 19.4 per cent. Additional successful cases of partial excision of the clavicle reduce the death-rate of that operation to only 14 per cent.

I have once excised the *sterno-clavicular articulation* in a case of unreduced dislocation with marked deformity, suturing the resected bones together, and obtaining a satisfactory result.

SCAPULA.—Total excision of the scapula, *the arm being preserved*, appears to have been now practised in 59 cases, the additional successful operations, since the publication of the table in Vol. III., page 583, having been those of Ceci, Maclean, Phelps, Putti (two cases), Shutz, Simons, Southam, Symonds, and Walder, ten in all; the fatal operations, those of Brinton, Ceci, Cheever, and Poinsot, four in number; and the undetermined cases those of Bull, Dysart, and Weir. Wood's case, marked undetermined in the table, was a success. The whole 59 cases therefore have given 43 recoveries, 12 deaths, and 4 uncertain results—a mortality of determined cases of 21.8 per cent. Extirpation of the scapula *subsequent to amputation at the shoulder* has been practised in six cases additional to those tabulated in Vol. III., page 584, there having been two successful operations, by Conant and Lange; two

fatal, by Swaine and Wood; and two undetermined, by Blair and Jessett. The whole 20 cases have therefore given 13 recoveries, 5 deaths, and 2 uncertain results, a death-rate for determined cases of 27.7 per cent.

SHOULDER-JOINT.—My personal experience with shoulder joint excision now embraces nine cases, as shown in the annexed table, all the patients having recovered from the operation, though one, who was affected with general tuberculosis, died of phthisis three months afterward. The functional results have likewise been satisfactory, and, upon the whole, removal of the head of the humerus, though less frequently demanded in civil than in military practice, must be considered a valuable resource in cases of destructive disease of this articulation.

TABLE OF NINE CASES OF EXCISION OF THE SHOULDER.

No.	Sex, age, and date.	Nature of affection for which operation was required.	Result.	Remarks.
1	Male, 30, 1882	Suppurative arthritis	Recovered	Useful arm. University Hospital. See Vol. iii., page 587.
2	Male, adult, 1884	Caries	do.	Useful arm. University Hospital.
3	Female, adult, 1884	Necrosis of humerus	do.	Remainder of humerus subsequently removed. Useful arm. University Hospital.
4	Female, old, 1887	Caries	do.	Sinuses persisted. University Hospital.
5	Male, adult, 1888	Suppurative arthritis	do.	Useful arm. University Hospital.
6	Male, 12, 1888	Necrosis of humerus	do.	Sinuses persisted. Children's Hospital.
7	Male, adult, 1889	Caries	do.	Useful arm. University Hospital.
8	Male, adult, 1891	Caries	do.	General tuberculosis. University Hospital.
9	Male, adult, 1895	Caries	do.	Under treatment. University Hospital.

SHAFT OF HUMERUS.—In a case of acute necrosis of the humerus, occurring in a woman, I removed the head and upper portion of the bone, and some weeks afterward, the disease recurring in the remainder, excised the lower portion, the two operations taking away the whole length of the bone, from shoulder to elbow. The muscles of the upper arm became markedly shortened, and the power of raising the arm was to a great extent lost, but the use of the hand and forearm was preserved, and the patient was able to pursue her occupation as a sempstress. I have also resected the humerus in several additional cases of ununited fracture, with a fair measure of success.

ELBOW-JOINT.—To the ten cases of elbow-joint excision tabulated in Vol. III., page 596, I can now add eighteen, with only two deaths—one from tuberculosis subsequent to consecutive amputation, and one from traumatic gangrene; in this case, as in two successful operations for necrosis, partial excision was resorted to. In a third case, the patient died after recovery, from abscess of the brain following middle-

ear disease. In nine cases, it is known that a useful arm was preserved by the operation; recurrence took place in three syphilitic cases; and the ultimate functional result in three was not determined. Of my whole number of 28 cases, six proved fatal (21.4 per cent.), but in only two of these was the unfavorable result directly attributable to the operation, death in both instances being due to gangrene.

TABLE OF EIGHTEEN ADDITIONAL CASES OF EXCISION OF THE ELBOW.

No.	Sex, age, and date.	Nature of affection for which operation was required.	Result.	Remarks.
11	Male, 30, 1884	Gelatinous arthritis.	Recovered	Useful arm. University Hospital.
12	Male, adult, 1884	.....	do.	do.
13	Male, 5, 1885	Syphilitic necrosis and caries (hereditary)	do.	Partial excision. Children's Hospital.
14	Male, adult, 1886	Chronic arthritis	do.	Useful arm. University Hospital.
15	Male, youth, 1886	Tuberculous arthritis	Died	Arm amputated. University Hospital.
16	Male, 6, 1886	Syphilitic disease of joint (hereditary)	Recovered	Children's Hospital.
17	Male, 26, 1886	Compound fracture of elbow-joint	Died	Partial excision. Death on 5th day from gangrene. University Hospital.
18	Male, child, 1888	Necrosis of humerus	Recovered	Partial excision. Pennsylvania Hospital.
19	Male, adult, 1888	Compound dislocation of elbow	do.	Useful arm. Pennsylvania Hospital.
20	Male, 30, 1888	Syphilitic caries	do.	Sinuses persisted. University Hospital.
21	Female, child, 1888	Chronic arthritis	do.	Death subsequently from intracranial abscess following disease of middle ear. Children's Hospital.
22	Male, 16, 1889	Syphilitic arthritis and necrosis	do.	Disease recurred. Pennsylvania Hospital.
23	Male, 15, 1889	Suppurative arthritis	do.	Useful arm. University Hospital.
24	Male, adult, 1891	Caries	do.	do.
25	Male, adult, 1891	Syphilitic arthritis	do.	Disease recurred. Pennsylvania Hospital.
26	Male, adult, 1893	Chronic arthritis	do.	Useful arm. University Hospital.
27	Male, 10, 1893	Unreduced dislocation of elbow and fracture of inner condyle	do.	do.
28	Male, 10, 1893	Unreduced dislocation of elbow and fracture of outer condyle	do.	do.

RADIUS AND ULNA.—I have thrice had occasion to resect portions of *both bones* of the forearm—twice for ununited fracture, and once for deformity following a badly treated fracture—and in all three cases with success. I have also resected the *radius* alone in two cases additional to those referred to in Vol. III., one being a case of ununited fracture with marked displacement, and the other a case of rachitic curvature; the result in both instances was satisfactory. Three times I have resected portions of the *ulna* alone; once successfully, for compound fracture from the bite of a mule; and twice unsuccessfully—in

one case for syphilitic necrosis, the patient dying some time afterward from visceral disease of the same character, and in the other case for sarcoma of the ulna, the disease promptly recurring, as it did again after amputation, and the patient dying from secondary growths in the thorax.

WRIST-JOINT AND CARPUS.—I have not had occasion to resort to complete excision of the carpus and wrist-joint, and my judgment as to this operation remains the same as that expressed in Vol. III., viz., that it is seldom required, most cases of wrist-disease which call for any operation being better adapted to amputation than to excision. I have, however, in one case removed the first row of the carpus with the articulating extremities of the radius and ulna, and in another case the second row of the carpus, both patients recovering from the operations, but sinuses persisting when they passed from my observation, so that I cannot speak of the ultimate result as regards functional utility.

HIP-JOINT.—My personal experience with excision of this articulation now embraces fifty-eight cases, one of which was a re-excision for recurrent disease.

TABLE OF THIRTY-SEVEN ADDITIONAL CASES OF EXCISION OF THE HIP.

No.	Sex, age, and date.	Nature of affection for which operation was required.	Result.	Remarks.
22	Male, 25, 1884	Bony anchylosis with caries and sinuses	Recovered	Femur divided *in situ*, and head of bone removed with gouge. University Hospital.
23	Male, child, 1884	Hip-disease in suppurative stage	do.	Children's Hospital.
24	Male, 11, 1884	do.	do.	do.
25	Male, 10, 1884	do.	do.	University Hospital.
26	Female, 11, 1884	do.	do.	Children's Hospital.
27	Male, 15, 1884	do.	do.	Useful limb. University Hospital.
28	Male, 26, 1885	Recurrent caries after excision	Died	Death from suppurative osteo-myelitis of femur and septic peritonitis. University Hospital. Same patient as No. 22.
29	Female, child, 1886	Hip-disease in suppurative stage	Recovered	Children's Hospital.
30	Female, child, 1886	do.	do.	do.
31	Female, 3, 1886	do.	do.	do.
32	Male, 8, 1886	do.	do.	do.
33	Male, 8, 1886	do.	do.	do.
34	Male, 9, 1887	do.	do.	Case of double hip-disease. Excision of right hip. University Hospital.
35	Male, 9, 1887	do.	do.	Same patient as No. 34. Excision of left hip. University Hospital.
36	Male, youth, 1887	Necrosis. General tuberculosis	Died	Death from phthisis. University Hospital.
37	Female, 10, 1887	Hip-disease in suppurative stage	Recovered	Children's Hospital.
38	Male, 24, 1888	Caries and anchylosis	Died	Death on 8th day. University Hospital.
39	Female, 16, 1888	Hip-disease in suppurative stage	do.	Death on 3d day. Pennsylvania Hospital.

TABLE OF THIRTY-SEVEN ADDITIONAL CASES OF EXCISION OF THE HIP.—*Continued.*

No.	Sex, age, and date.	Nature of affection for which operation was required.	Result.	Remarks.
40	Male, 35, 1888	Caries	Died	Death after 1 year. University Hospital.
41	Female, child, 1888	Acute necrosis	Recovered	Children's Hospital.
42	Male, child, 1888	Caries	do.	do.
43	Male, 11, 1889	Necrosis and perforation of of acetabulum. Suppurative osteitis of femur	Undetermined	Phthisis 4 months after operation. University Hospital.
44	Male, 6, 1889	Hip-disease in suppurative stage	Recovered	Children's Hospital.
45	Male, child, 1889	do.	do.	do.
46	Male, 11, 1890	do.	do.	Pennsylvania Hospital.
47	Male, 17, 1890	Anchylosis and caries	do.	Femur divided *in situ*; head of bone removed with gouge. University Hospital
48	Male, 11, 1890	Anchylosis with extreme deformity	do.	Bone removed with gouge and forceps. University Hospital.
49	Male, 9, 1891	Caries	do.	Children's Hospital.
50	Female, 8, 1892	Hip-disease in suppurative stage	do.	Pennsylvania Hospital.
51	Male, child, 1892	do.	do.	do.
52	Male, 3½, 1892	do.	do.	Children's Hospital.
53	Female, 17, 1893	do.	do.	University Hospital.
54	Male, 6, 1893	do.	do.	Children's Hospital.
55	Male, 4, 1893	do.	do.	do.
56	Female, 6, 1893	do.	do.	do.
57	Female, 21, 1894	do.	do.	Disease had lasted 15 years; head of bone separated and bone in acetabulum. Pennsylvania Hospital.
58	Male, 12, 1894	do.	do.	Pennsylvania Hospital.

Of the two patients still under treatment when the table in Vol. III., page 612, was printed, one recovered and the other died, while of the 37 additional cases now tabulated 5 proved fatal and the result of one is undetermined; the whole 58 operations, therefore, have given 45 known recoveries and 12 deaths, a mortality in determined cases of 21 per cent. This small general mortality is still further reduced if the cases occurring in children only are considered, 51 operations in persons less than 20 years old having given 42 recoveries, 1 undetermined, and only 8 deaths (16 per cent.), and is strikingly contrasted with the death-rate which attends the operation in adults, 7 cases in persons more than 20 years of age having given only 3 recoveries and 4 deaths, over 57 per cent. Indeed, excision of the hip is such a grave procedure in adult life, that it should not be recommended, under these circumstances, unless in very exceptional cases.

I have in one case, in a girl of 17, resorted to amputation at the hip-joint subsequent to excision, caries having recurred some months after the latter operation, which had been performed with temporary benefit by my colleague Dr. Packard. The patient has recovered and improved much in health, though a few sinuses still persist. Amputation subsequent to excision has been practised in 37 cases to which I have references, 22 ending in recovery, with 10 deaths and 5 undetermined, while primary amputation for hip disease appears to have been

employed in 55 cases, with 42 recoveries, 11 deaths, and 2 undetermined; so that, apart from the mutilation necessarily entailed by this procedure, its death-rate is but fractionally less than that of excision, which will therefore properly be preferred in all suitable cases.

FEMUR.—I have in one instance resected a small portion of the femoral shaft in a case of badly united fracture, fixing the fragments with a buried silver splint as advised by Dr. Halsted, of Baltimore. The patient made a good recovery, with a useful limb, the silver splint remaining *in situ* without causing any disturbance.

KNEE-JOINT.—In the article on Excisions, in Vol. III., page 632, I tabulated 26 cases in which I had excised the knee-joint, and I now

TABLE OF FIFTY-EIGHT ADDITIONAL CASES OF EXCISION OF THE KNEE.

No.	Sex, age, and date.	Nature of affection for which operation was required.	Result.	Remarks.
27	Male, 25, 1884	Gelatinous arthritis; caries and consecutive dislocation	Died	Death in eight weeks from bed-sores. University Hospital.
28	Male, 25, 1884	Gelatinous arthritis and caries	Recovered	Useful limb. University Hospital.
29	Male, 14, 1884	Suppurative arthritis	do.	do.
30	Male, 25, 1885	Syphilitic arthritis	Died	Death on 7th day from secondary hemorrhage. University Hospital.
31	Male, 16, 1885	Syphilitic arthritis (hereditary)	Recovered	Useful limb; sinuses. University Hospital.
32	Male, 5, 1885	Gelatinous arthritis	do.	Children's Hospital.
33	Male, 16, 1886	do.	do.	Useful limb. University Hospital.
34	Male, 35, 1886	Chronic disease of articulation, 22 years	do.	do.
35	Male, 35, 1886	Bony anchylosis, with caries and great deformity	do.	Useful limb; excision *en bloc*. University Hospital.
36	Male, 4, 1886	Suppurative arthritis	do.	Children's Hospital.
37	Female, 3, 1886	do.	do.	do.
38	Male, 9, 1886	Anchylosis and deformity	do.	do.
39	Female, 16, 1887	Suppurative arthritis and caries	do.	Useful limb. University Hospital.
40	Female, 25, 1888	Anchylosis and deformity. Recurrent arthritis, 18 years	do.	do.
41	Male, 6, 1887	Gelatinous arthritis	do.	do.
42	Male, adult, 1887	Bony anchylosis, with deformity and suppuration	do.	do.
43	Female, adult, 1887	Fibrous anchylosis; limb painful and useless	do.	do.
44	Male, adult, 1887	Gelatinous arthritis	do.	do.
45	Male, 1888	Suppurative arthritis and caries	do.	do.
46	Male, 45, 1888	Suppurative arthritis and caries	do.	do.
47	Male, 35, 1888	Fibrous anchylosis, with deformity and recurrent arthritis	Died	Death in 5 weeks. Gluteal abscess. Pennsylvania Hospital.
48	Female, 6, 1888	Arthritis, 3 years	Recovered	Useful limb. University Hospital.
49	Female, 37, 1888	Arthritis and anchylosis, with deformity	do.	do.
50	Male, adult, 1888	Suppurative arthritis	do.	Useful limb. Pennsylvania Hospital.
51	Male, 45, 1888	Acute suppurative arthritis	do.	Useful limb. University Hospital.
52	Male, 11, 1888	Gelatinous arthritis and consecutive dislocation	do.	do.

TABLE OF FIFTY-EIGHT ADDITIONAL CASES OF EXCISION OF THE KNEE.—*Continued.*

No.	Sex, age, and date.	Nature of affection for which operation was required.	Result.	Remarks.
53	Male, 8, 1888	Gelatinous arthritis and caries	Recovered	Useful limb. Children's Hospital.
54	Female, 25, 1889	Fibrous anchylosis and recurrent arthritis	do.	Useful limb. University Hospital.
55	Male, 55, 1889	Suppurative arthritis and caries	do.	Fibrous union only. University Hospital. See No. 65.
56	Male, 25, 1889	do.	do.	Useful limb. University Hospital.
57	Male, 25, 1889	Caries and partial anchylosis	do.	do.
58	Male, 19, 1890	Chronic disease of joint	Died	Death in 5 hours from shock. Pennsylvania Hospital.
59	Male, adult, 1890	do.	Recovered	Useful limb. Pennsylvania Hospital.
60	Male, adult, 1890	do.	do.	do.
61	Male, 6, 1890	do.	do.	do.
62	Female, 20, 1890	do.	do.	do.
63	Female, 19, 1890	Tubercular arthritis	do.	Useful limb. University Hospital.
64	Male, 6, 1890	Arthritis and partial anchylosis, with deformity	do.	Children's Hospital.
65	Male, 57, 1891	Fibrous union after previous excision	do.	Re-excision. See No. 55. Useful limb. Pennsylvania Hospital.
66	Male, 36, 1891	Arthritis and caries, 20 years	do.	do.
67	Female, 25, 1891	Arthritis and caries	do.	Useful limb. University Hospital.
68	Female, 9, 1891	Gelatinous arthritis	do.	Useful limb. Children's Hospital.
69	Male, adult, 1891	Caries and abscess of tibia	do.	Useful limb. University Hospital.
70	Female, 30, 1891	Arthritis and fibrous anchylosis	do.	do.
71	Male, child, 1892	do.	do.	Useful limb. Children's Hospital.
72	Female, adult, 1892	Arthritis and caries	do.	Recovered from operation. Became insane. Pennsylvania Hospital.
73	Female, young, 1892	Necrosis of lower end of femur	do.	Partial excision (lower end of femur); useful limb. Pennsylvania Hospital.
74	Male, adult, 1892	Tubercular arthritis	do.	Useful limb. Pennsylvania Hospital.
75	Male, 52, 1892	Arthritis and caries	do.	Recovered after amputation for recurrent caries. University Hospital.
76	Female, child, 1892	Gelatinous arthritis	do.	Re-excision for recurrent disease; ultimately, useful limb. Children's Hos.
77	Male, 7, 1893	Recurrent disease after arthrectomy	do.	Useful limb. University Hospital.
78	Female, adult, 1893	Tubercular arthritis	do.	Fibrous union. University Hospital.
79	Female, adult, 1893	Caries	do.	Useful limb. University Hospital.
80	Female, 12, 1893	Gelatinous arthritis, with deformity	do.	Children's Hospital.
81	Male, 12, 1893	Traumatic suppurative arthritis	do.	Useful limb. Children's Hospital.
82	Female, 10, 1894	Fibrous anchylosis	do.	do.
83	Male, adult, 1894	Tubercular arthritis; abscess of thigh and leg	Died	Death from mania-à-potu. University Hospital.
84	Male, youth, 1894	Gelatinous arthritis, with deformity	Recovered	Useful limb. University Hospital.

have to add 58 more, making a total of 84 operations. The two patients recorded as "still under treatment," when Vol. III. was published, both recovered, and of the 58 additional cases 53 terminated favorably and only 5 in death, the whole 84 cases therefore giving 77 recoveries (2 after subsequent amputation) and only 7 deaths, a mortality of but 8.3 per cent., while a useful limb is known to have been obtained in at least 63, or 78.2 per cent. In view of these figures I confess to have read with some surprise, in the account of a recent discussion on the subject in a neighboring city, the apparently uncontradicted assertion that surgeons generally do not favor knee-joint excision, but look upon the operation with distrust. Certainly an operation after which only one patient in twelve perishes, and which secures a useful limb in three-fourths of the cases in which it is employed, is preferable to amputation, which ordinarily is the only alternative, and is entitled to confidence rather than distrust. I have been encouraged by the good results afforded in my hands by knee-joint excision, to extend the age-limit which I had formerly adopted, in either direction, and my table now includes successful operations in a child of 3 and in an adult of 57.

Arthrectomy in Knee-Joint Disease.—The operation of *arthrectomy*, or *erasion of joints*, introduced by Wright, of Manchester, consists in laying open the joint, as for an excision, and then cutting away with knife or scissors, or scraping away with the sharp spoon, all the soft tissues of the articulation, without removing any portion of the bone, or at most using the gouge only superficially. In the case of the knee, the ligament of the patella is divided, and its segments are afterward brought together again with chromicized catgut sutures. The semilunar cartilages are of course removed. When the case does well, union occurs by fibrous anchylosis, the joint-cavity being obliterated by firm adhesions. The result of this operation, in the knee, at least, is very satisfactory, the shape of the articulation being preserved and the limb being extremely useful; it is, however, a more tedious procedure than excision, and, the cure being effected by fibrous and not by bony anchylosis, there is a good deal of tendency to subsequent contraction, requiring the use for a long time of external support. I have resorted to arthrectomy of the knee in eleven cases, ten of the patients recovering from the operation, though in one instance recurrent caries required consecutive excision, which was followed by rapid cure. The eleventh case terminated fatally on the thirty-seventh day, from causes unconnected with the operation, the wound having done well throughout. The nine other patients recovered with useful limbs.

PATELLA.—I have twice practised total excision of the patella: once, as a primary operation, in a case of compound fracture with comminution, the patient making a good recovery; and once, as a secondary procedure, in a case originally of simple fracture, in which another surgeon had unsuccessfully employed bone-suture, and in which, when the patient came under my care, the knee-joint was full of pus, and the patella was carious. This patient improved temporarily after the operation, but subsequently large congestive abscesses formed in the leg, and death ultimately resulted from chronic septic infection. A legitimate resource in certain cases of compound fracture, the opera-

tion of complete excision of the patella is necessarily attended by considerable risk, and seems to me to have but a limited field of application.

BONES OF THE LEG.—Beside the case referred to in Vol. III., page 561, of resection of the tibia and fibula for deformity, I have operated in two cases of anterior curvature from rachitis (cuneiform osteotomy) —in one of these cases three times—and twice for non-union following the same procedure. I have also successfully excised the entire shaft of the tibia in a case of acute necrosis, rapid reproduction of bone taking place from the periosteal sheath, and the patient making an excellent recovery. In another case I removed about one-third of the shaft; also with good results. The operation for rachitic curvature I have found disappointing, for although union as a rule occurs without difficulty, and the leg appears straight and firm, the deformity is apt to recur (on account of the morbid condition of the bones), and in a few years may be as marked as before the operation. To prevent this, if possible, the patient should be required to wear a firm artificial support long after consolidation appears to be complete, should take such remedies as cod-liver oil and phosphorus, and should be placed in such hygienic conditions as may assist in eradicating the disease.

ANKLE-JOINT.—Excision of the ankle I have practised in 13 cases, as shown in the annexed table, two patients having died some months after the operation, two having submitted to subsequent amputation (successful), and nine having recovered without further interference, one of these, however, having a sinus still persisting when last

TABLE OF THIRTEEN CASES OF EXCISION OF THE ANKLE.

No.	Sex, age, and date.	Nature of affection for which operation was required.	Result.	Remarks.
1	Male, 3½, 1875	Caries of ankle-joint	Died	Death in 4 months from phthisis. Wound did well. Children's Hospital.
2	Male, 20, 1880	Chronic arthritis	do.	Death in 9 months from phthisis. University Hospital.
3	Male, child, 1885	do.	Recovered	Children's Hospital.
4	Female, child, 1888	Caries; sinuses	do.	University Hospital.
5	Male, 10, 1888	Caries	do.	Pennsylvania Hospital.
6	Male, adult, 1888	Compound fracture and dislocation	do.	Useful limb. Pennsylvania Hospital.
7	Male, adult, 1888	Compound fracture and dislocation	do.	Useful limb. University Hospital.
8	Female, adult, 1889	Caries	do.	Disease recurred and leg amputated 16 months afterward. University Hospital.
9	Male, child, 1889	Necrosis	do.	University Hospital.
10	Male, adult, 1890	Caries	do.	Sinus persisted. University Hospital.
11	Male, adult, 1890	do.	do.	Disease recurred and leg amputated 4 months afterward. Pennsylvania Hospital.
12	Male, adult, 1890	Gelatinous arthritis	do.	Pennsylvania Hospital.
13	Male, 40, 1890	Compound fracture	do.	Useful limb. University Hospital

seen. In traumatic cases the operation is a very satisfactory one, as it is in cases of chronic disease in children; but in adults, particularly in tuberculous cases, it is very difficult to be sure that all the morbid tissue has been removed, convalescence is greatly prolonged, and recurrence in the neighboring parts is apt to be met with, so that, upon the whole, I am disposed, in this class of cases, to look upon amputation as preferable, being a more certain means of affording relief, and enabling the patient to return sooner to the active duties of life. In the after-treatment of ankle-joint excisions I have latterly ceased to use the special splint recommended in Vol. III., page 640, and have employed a simple gutter of binder's-board, long enough to reach above the knee, and extending several inches below the foot, the limb, as an additional precaution, being placed in a large fracture-box.

ASTRAGALUS.—I have removed the astragalus 16 times. in 9 cases for caries or necrosis, and in 7 for club-foot. In two cases of the former category the os calcis was removed at the same time, one patient making a good recovery and the other dying some months subsequently from pulmonary tuberculosis, and in a third case consecutive amputation was successfully practised for recurrent disease. Of the club-foot cases six were examples of pes varus and one of pes valgus. The patient in this last case was a girl of 10 years, who made

TABLE OF SIXTEEN CASES OF EXCISION OF THE ASTRAGALUS.

No.	Sex, age, and date.	Nature of affection for which operation was required.	Result.	Remarks.
1	Male, 49, 1873	Caries	Recovered	Episcopal Hospital.
2	Male, 50, 1880	do.	Died	Calcaneum also removed. Death in 5 months. University Hospital.
3	Male, adult, 1884	do.	Recovered	University Hospital.
4	Female, adult, 1884	Necrosis	do.	do.
5	Male, child, 1885	Caries	do.	do.
6	Male, adult, 1885	Pes varus	Died	Anterior tarsus also removed. Foot became gangrenous; amputation of leg. Death. University Hospital.
7	Male, adult, 1886	Caries	Recovered	Disease recurred and leg amputated. University Hospital.
8	Male, child, 1889	do.	do.	Calcaneum also removed. University Hospital.
9	Male, child, 1890	Pes varus	do.	Useful foot. Children's Hospital.
10	Male, child, 1890	do.	do.	Scaphoid also removed. University Hospital.
11	Male, child, 1890	Caries	do.	Scaphoid also removed. Pennsylvania Hospital.
12	Male, 10, 1890	Pes varus	do.	Useful foot. Pennsylvania Hospital.
13	Male, child, 1892	do.	do.	Useful foot. University Hospital.
14	Male, 15, 1892	do.	do.	Useful foot. Pennsylvania Hospital.
15	Female, 10, 1892	Pes valgus	do.	Died from diphtheria 3 months after operation. Children's Hospital. Useful foot.
16	Male, child, 1894	Pes varus	do.	Pennsylvania Hospital.

a good recovery, with the foot in excellent position, but died three months afterward from diphtheria. Of the varus cases five were successful, the scaphoid as well as the astragalus having been removed in one of these, and one terminated fatally. This was a case of very great deformity in an adult, and amputation would have been a safer remedy than excision. A great part of the anterior tarsus was removed as well as the astragalus, and considerable force was used in bringing the foot into position; gangrene ensued, and in spite of prompt amputation death followed.

The following table exhibits in a condensed form the results of my personal experience in excisions of the six larger joints:—

TABLE SHOWING THE RESULTS OF 193 CASES OF EXCISION OF THE SIX LARGER JOINTS.

	Recovered.	Died.	Undetermined.	Total.	Mortality, per cent.
Shoulder	9	0	0	9	0.00
Elbow	22	6[1]	0	28	21.43
Wrist	1	0	0	1	0.00
Hip	45	12	1[2]	58	21.05
Knee	77[3]	7	0	84	8.33
Ankle	11[4]	2	0	13	15.38
Aggregates	165	27	1[2]	193	14.06

[1] One died after amputation.
[2] Undetermined case omitted in calculating percentages.
[3] Two recovered after amputation.
[4] Two recovered after amputation.

ORTHOPÆDIC SURGERY.

BY

DE FOREST WILLARD, M.D.,

CLINICAL PROFESSOR OF ORTHOPÆDIC SURGERY IN THE HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PRESBYTERIAN HOSPITAL, PHILADELPHIA.

THE derivation of the word "orthopædic" is variously given by authors; some regarding it as having been derived from ὀρθός, straight, and παιδεύω, to educate—an excellent combination of ideas — while others, more properly, claim that the term is derived from ὀρθός, straight, and παις, παιδος, a child; from the straightening of children it has been enlarged to include the straightening of deformities occurring at all ages. The orthography of the word when *e* is used instead of *æ* leads many professional men, as well as others, to suppose that the latter portion of the word is derived from the root *ped*, the foot; thus limiting and narrowing the application of the term. The retention of the diphthong is, therefore, especially useful and suggestive. Mr. Fisher, in the article on Orthopædic Surgery in Vol. III., would limit the term to subcutaneous work; but this is certainly unjustifiable, as there are many orthopædic operations which are not subcutaneous. Excisions, erasions, osteotomies, open tenotomies, etc., are certainly very essential procedures in the correction of deformities.

Orthopædic surgery is simply one of the divisions of general surgery. It deals with all classes of deformities and malformations. For its proper understanding the surgeon must acquire a thorough mastery of general surgery, and must add thereto an accurate knowledge of the various accessory mechanical means to be employed; in short, it includes the prevention and the operative and mechanical treatment of all deformities, congenital or acquired, but especially of those affecting the osseous and muscular systems.

The following pages are to be regarded as supplementary to Mr. Fisher's article, already referred to, and follow the same order of arrangement, as far as practicable.

CLUB-FOOT.

SUBCUTANEOUS TENOTOMY OF THE TENDO ACHILLIS.—Division of the tendo Achillis is best accomplished, and with least risk of accident, by making a puncture—not an incision—in the skin with an exceedingly sharp-pointed tenotome, and completing the section with a blunt-pointed instrument with a short cutting edge, thus preventing either punc-

ture of the skin upon the opposite side or enlargement of the external wound.

In old contractions, and in secondary operations, a second section may be demanded, the latter being made at the insertion of the tendon into the calcaneum. If the foot is fixed firmly in a gypsum dressing after the operation, and the proper position of the joint is maintained, there will be no risk of a deficiency of tissue or of a superabundance. In some cases, three inches may safely be inserted in this tendon without risk. The amount of material which nature will pour out for the repair depends upon the primary position of the ends of the tendon. If the foot is dressed in the original position, and the two ends are but slightly separated, say one-quarter of an inch, the amount of material poured out will be equal only to the amount needed for repair of this interval; should the foot be subsequently extended so that the gap is increased to one inch, this exudate will be elongated to four times its capacity, and the result will be a weak tendon with only one-fourth its necessary structure. After tenotomy, therefore, the foot should always be placed in the *fully corrected* position, fixed with plaster-of-Paris or other splint, and kept at absolute rest for two weeks, after which the patient can walk about on the cast for one or two weeks more. Proper apparatus should then be applied.

The tendon is sometimes divided by open incision, the exact amount of lengthening being secured by longitudinal splitting and flaps cut from opposite sides, the flaps being then sutured with catgut. This procedure gives no greater accuracy than does the subcutaneous method when a fixed position is maintained, and even with asepsis is not as free from danger.

The statement of Mr. Fisher, that section of the tendo Achillis is always to be avoided in spasmodic equinus, does not at all agree with American practice, since it has been found that great benefit has been obtained from the improved mechanical position of the foot after tenotomy. Moreover, the greatly increased powers of locomotion secured by the operation add markedly to the functional activity of all the muscles, and secondarily to the mental gain of the individual. Even when recontractions occur in severe spastic cases, a second section will usually result in permanent benefit.

The slight degree of equinus in which the foot can only be brought to a right angle, especially when there is an associated condition of cavus, is often accompanied by much inconvenience and pain. Tender callosities make locomotion an act of great discomfort, and the gait is laborious. Section of the tendo Achillis gives great relief.

In the so-called "non-deforming club-foot" a very considerable amount of deformity really exists, and tenotomy is often serviceable.

ANATOMICAL CHANGES IN CONGENITAL VARUS.—The astragalus is the bone most distorted by muscular action, by pressure, or by weight-bearing. The tarsus is not only misshapen at birth, but even the slight pressure of clothing upon the infant foot during the first few months of life may cause such further malformation that difficulty will be experienced in any attempt to replace the foot in its normal position. As soon as the patient begins to walk the deformity will rapidly increase.

Morton says that the astragalus is sometimes so misshapen as to be unrecognizable, and partially displaced forward so that it even does not articulate with the tibia and fibula. In old cases the distortion is exceedingly great, the neck especially becoming misshapen and rotated.

The os calcis, from pressure, is often twisted, and forms laterally an oblique angle to the line of the leg, which is very difficult to overcome even after operation. The other bones of the foot, particularly the cuboid and scaphoid, from continuous pressure become wedge-shaped, and their replacement in adult life is almost impossible. In addition to this, all the ligaments, fasciæ and connective tissue upon the inner side of the arch become shortened, while the tissues and ligaments upon the outer side are greatly elongated.

TREATMENT OF CONGENITAL VARUS.—Infantile talipes cases are frequently neglected by physicians for many months, during which time the exceedingly rapid growth of the bones during the first three months of life, together with the pressure of the clothing, tends to greatly increase the bony distortion and render subsequent rectification difficult. The proper time to commence the treatment is immediately after birth.

The most common methods of correcting varus may be classified under the following heads: (1) Manipulation; (2) Mechanical devices for straightening; (3) Multiple tenotomies with forcible immediate rectification followed by fixation in the corrected position; (4) Open incision; (5) Tarsotomy; (6) Tarsectomy; (7) Amputation.

(1) *Manipulation.*—Hand stretching of all the contracted tissues with massage of the disabled peroneals is by far the most effective means of rectification of an equino-varus. If thoroughly performed, it will nearly always avoid the necessity for operation, and even when partially employed it is a great service in securing pliable feet. Rectification can be employed many times during the day to the point of imparting only slight pain to the infant. The amount of improvement is usually in exact proportion to the amount of intelligent manipulation which is received.

(2) *Mechanical Appliances.*—Any simple splint will answer for keeping the foot in position. The exceedingly small size of the heel makes retention difficult without adhesive plaster, but with care excoriations can be prevented. A piece of sole leather, or felt, or tin, or aluminium, cut and fitted in the shape of a half boot and applied along the inner side of the leg and foot, will keep it in place. As the foot grows, gypsum bandages frequently applied in advancing stages of rectification are useful when parents have not time to practise manipulation. These plaster boots, if slit open and the foot straightened frequently, are very useful, especially in dispensary work. Wolf's plan is to cut out from time to time a section of the cast upon the convexity of the arch, to forcibly straighten the foot, and to fix it in the corrected position by a few turns of plaster bandage.

As soon as the position is sufficiently improved to admit of the retention of an apparatus, an appliance that will admit of manipulation without removal of the brace is the best for cases occurring among the poor, or with those who cannot give time to the treatment. Such forms of

[1] Trans. Amer. Surg. Assoc., vol. viii., 1890, p. 71.

apparatus are articulated opposite both ankle and medio-tarsal joints, and are acted upon by elastic or by spring force.

Other useful appliances are operated upon by screw or cog-wheel, or lever power.[1] The object to be secured is the unfolding of the varus, the elongation of the contracted tissues, and the strengthening of the weakened muscles. The forms of apparatus are almost numberless.

Time for Operation.—The preliminary course of manipulation and mechanical treatment already outlined, gives a mobile and flexible foot, and will, in many instances, secure a good result without operation. In stubborn cases, however, and in individuals where detail cannot receive proper attention, tenotomies become necessary. The proper time for this procedure will vary with each individual case. In those which fail to improve, and when the position is so abnormal that retention of apparatus is impossible, early sections are helpful; but in the majority of cases delay is admissible in cases which are doing well until the child attempts to walk. If the cure of a case of equino-varus is not sufficiently advanced to permit the sole of the foot to be placed squarely upon the ground when the child begins to walk, the rule should be to delay operation no longer, since every step will rapidly deform the bones.

Asepsis.—In every case the most rigid care should be given to prevent the entrance of suppurative germs. Scrupulous cleanliness of hands, instruments, and dressings is important. It is a difficult task to thoroughly cleanse and prepare an adult foot that is covered with callosities, and much time, patience, and hard scrubbing are essential. The preliminary use of a hot flaxseed poultice for several days is of service.

(3) *Multiple Tenotomies and Immediate Forcible Straightening with Subsequent Fixation in the Corrected Position.*—Every contracted tissue should be divided, some cases requiring more cutting than others, but the tibialis anticus and posticus are nearly always at fault. The rules for their section are fully given in Mr. Fisher's article. If the plantar fascia is resistant it should also be cut, and the varus forcibly corrected, reserving the section of the tendo Achillis until the close of the operation in order to retain its fulcrum power.

The advice is often given to correct the varus at one operation, and to postpone the operation for equinus until a later date. When a surgeon has free control of his patient, and time is of no consequence, such a course is sometimes of advantage; but in the majority of cases it is wiser to thoroughly correct the varus by forcible measures, and then, just at the end of the operation, to divide the tendo Achillis, after which the relief of the equinus can be accomplished provided the astragalus is not too distorted to assume its relation between the malleoli.

Immediately after complete and thorough rectification the foot is loosely encased in a plaster-of-Paris bandage, which puts the parts perfectly at rest. It may remain two or three weeks without disturbance if thorough attention has been given to asepsis of the foot, instruments, and dressings. Metal splints or other apparatus are often used, but are not as comfortable as the gypsum, if it is evenly, lightly, and carefully applied.

A walking apparatus of any desired form should subsequently be used, and the parents should be educated to manipulate and practise

[1] Agnew's Surgery, 2d ed., vol. iii., p. 342.

massage on the foot for months and even for years to prevent relapse, to which there is necessarily a constant tendency.

The most troublesome resultant condition to overcome will be the tendency to inversion of the toes. This is best obviated by full correction at the time of the operation, the subsequent long-continued use of everting manipulations and gymnastics for ankle, legs, and thigh, and the employment of apparatus extending to the pelvis so as to compel eversion. The spiral spring of Doyle is also useful.

Operations in Older Children and in Adults.—When a club-foot has been subjected to weight-bearing for a number of years, the distortion of bones and the contraction of tissues become exceedingly great, and most forcible measures become necessary. Unless months or years are to be consumed in the treatment, it should be commenced by operative measures. Multiple and free sections of all contracted tendons and tissues should be the rule, and full and complete rectification at the time of operation should be accomplished if possible.

The division in the worst cases may include not only tendons and fasciæ, but also the shortened internal ligaments, and sometimes everything but the skin; thus making a section as complete as an open incision, except that it is subcutaneous and does not leave the scar of the latter operation. Necessarily the internal plantar artery is divided, but I have never seen any serious result therefrom. A very strong-shanked tenotome is needful for the plantar section.

Tearing of the skin upon the inner side of the arch is rarely occasioned, and even should it happen, the operation may be completed by clean open section, just as if the latter had been undertaken as a primary procedure.

When the surgeon lacks strength to straighten the deformity he may employ Thomas's wrench, or the powerful instruments of Bradford,[1] Morton,[2] and others. The use of these tarsoclasts is attended with danger to the soft parts, and pressure must not be prolonged. Hand pressure over a smooth wood fulcrum is safer.

(4) *Open Incision.*—This operation, commonly known as Phelps's, attacks the deformity by a complete open division of all the contracted tissues in the concavity of the arch, by elongation of this space, and by filling the gap with granulation tissue. When the internal lateral ligaments are divided, the foot can be elongated, and becomes a better walking member than when the convexity of the arch has been disturbed by bone removal.

The incision extends from a half-inch in front of the internal malleolus, across the sole as far as necessary. The artery and nerve should be avoided if possible, but section of both tibial tendons and of all the contracted fasciæ is necessary, and sometimes division of the abductor pollicis, flexor brevis, and the entire internal ligaments is demanded.

(5) *Tarsotomy.*—Astragaloid osteotomy has been occasionally employed with success, and is a perfectly feasible operation. After thorough tenotomy, fasciotomy, and stretching, an incision is made from the tip of the inner malleolus to the inner side of the head of the first metatarsal, nearly parallel to the tibialis anticus tendon. Care should be exercised lest the scaphoid be mistaken for the astragalus. After

[1] Bradford and Lovett, Orthopædic Surgery, 1890, p. 484.
[2] Trans. Amer. Orthop., Assoc., vol. i., and Agnew's Surgery, 2d ed., vol. iii. p. 343.

division of the neck of the latter with a small osteotome, forcible straightening is completed. Thorough antisepsis is essential.

(6) *Tarsectomy.*—No positive rules based upon the age of a patient can be laid down as regards excision of the tarsal bones. The justifiability of operation must depend upon the conditions encountered. There are cases in adults which can easily be cured without mutilation of the tarsal arch, and there are instances in young children (but not in infants) where such a procedure may become the proper surgical course. The first element, therefore, in determining the propriety of excision would be the rigidity of the foot. This will depend largely upon the alteration in shape of the osseous tissues, and secondly upon the density of the contractions in the fasciæ and tendons.

Some surgeons advocate the removal of the astragalus even in young children; but the large majority of American surgeons reserve such operations for older patients, and for more resistant cases.

The second indication for excision will, of course, be the degree of deformity, and the possibility of securing a good walking foot which can be planted squarely upon the sole, and which can be brought to extension at least slightly beyond a right angle with the leg. In many cases in adults the operation is perfectly justifiable, and will greatly improve the locomotion of the individual.

Another element in reaching a decision will be the condition and control of the patient. In many instances where time is of no consequence, where care and attention will be given to the instructions of the surgeon, and where the nursing of the patient will be assiduous, the less radical measures may be employed, and will be successful. But in a case where it is certain that careful attention will not be given and that even the most careful instructions will be disobeyed, where time is of great consequence, and where it is certain that the failure of one operation will be followed by the refusal of another attempt at rectification, an excision becomes perfectly justifiable, though it would not have been so under the conditions first named.

Relapsed cases especially demand the operation. Another argument in favor of tarsectomy is that it sometimes places the foot in such corrected position that the use of apparatus can be dispensed with more speedily than when a less radical operation has been performed. This is often an element of importance. If, however, only one foot is involved, it is highly improbable that a patient will for many years be able to dispense with apparatus, as the unevenness of the gait tends to roll the foot upon its outer surface, especially if, as in many cases, the peroneals are paralyzed, and there is difficulty in maintaining the foot in the good position which has been secured by operation.

No surgeon, though careful to an extreme degree, can depend absolutely upon the varying conditions of materials, instruments, solutions, etc., which he has to use about a wound; hence the opportunities for admission of germs are not wanting, and occasionally suppuration will result. Wilson[1] gives the mortality in 435 cases as 1.6 per cent. A list of sixteen different forms of tarsectomy is given by Young,[2] but excision of the astragalus and wedge-shaped resection of the tarsus are the two chief operations.

[1] Trans. Amer. Orthopædic Assoc., 1893, vol. vi., p. 160.
[2] Orthopædic Surgery, p. 380. Phila., 1894.

Tarsectomy, while frequently justifiable, is mutilatory. It does not give as good motion at the ankle joint as can be secured when the astragalus remains in place, and when the deformity can be so treated that the foot can be flexed to a point beyond a right angle with the leg. Many an astragalus which seems hopelessly distorted, and so enlarged that it cannot be brought between the malleoli of the tibia and fibula, yet, with properly applied but strong force may be placed *in situ*, when in time the walking efforts of the individual will adapt it to proper relations. After all operations the atrophied and weakened muscles must be strengthened by persistent massage, to maintain the foot in the corrected position.

The incision for a tarsectomy should commence in front of, and below, the external malleolus, extending sufficiently forward to give a good exposure, and avoiding, if possible, the peroneal and extensor tendons. Disarticulation of the astragalus, the preferable operation, is not an easy matter, and the posterior tibial artery is in danger when the opposite ligaments are reached. A curved, blunt knife is serviceable.

The removal of the astragalus, when insufficient to permit complete rectification, may be followed by excision of the cuboid, or an irregular wedge-shaped excision, as advocated by Davy, may be performed.

When a wedge is to be removed, a chisel is preferable to a saw when the articulations are not followed.

Both rubber and gauze drainage are advisable until the first dressing. The foot should be firmly fixed with gypsum, or other rigid dressing, until healing is nearly completed, when gentle passive movements should be instituted to restore the function of the part, and afterward the patient should walk about upon the cast until a proper apparatus is adjusted.

Wedge-shaped excisions with either chisel or saw are sometimes necessary in adult cases when the cuboid is especially distorted. In some cases the lines of the articulations are followed, but more commonly the wedge section is made irrespective of these lines. Such an operation shortens the foot more than an excision of the astragalus, and more than an open incision on the inner side of the arch.

(7) *Amputation* may occasionally be justifiable in cases of extreme deformity occurring in adults.

Extension in the Treatment of Club-Foot.—The structural shortening of a foot may often be greatly benefited by the frequent and forcible application of an extension shoe, like that of Adams, described in Mr. Fisher's article,[1] or by the use of Shaffer's apparatus.[2]

VALGUS.—The deformity which is most likely to be overlooked by a careless surgeon is the variety of valgus in which the flexion (or rather hyper-extension) is apparently beyond the right angle. Close observation, however, will show that this is only apparent; that the appearance is caused by the undue amount of mobility at the transverse tarsal joint, while the relation of the calcaneum to the tibia and fibula is still faulty. The tendo Achillis is really too short, and each step only tends to bend the foot more and more at the calcaneo-cuboid and astragalo-scaphoid articulations, thus increasing the deformity.

[1] Vol. III., p. 686, *supra*. [2] Bradford and Lovett, Orthopædic Surgery, 1890, p. 471.

Tenotomy of the tendo Achillis in addition to that of the peroneals is always beneficial in these cases, provided an apparatus is subsequently adjusted with an arched leather or steel insole, which not only supports the normal arch of the inner portion of the foot, but is high enough to give support to the side of the scaphoid as well. The sole of the shoe should also be thicker along the entire inner side of the heel and ball of the foot, so that the tread will be upon the outer side.

If steel uprights are necessary, a pad should be placed opposite the inner ankle, and an elastic strap attached opposite the ball of the great toe so as to raise the inner side of the foot.

FLAT FOOT.—Gymnastics, massage, electricity, and improvement of general nutrition are essential elements in the treatment of flat foot. The tibialis anticus muscle must receive especial development by exercises systematically carried out.[1] Walking on tiptoe is often serviceable, but weight and pulley movements are especially indicated. The best shoe to be worn is that already described for the treatment of valgus. The supporting arch beneath and upon the inner side of the scaphoid may be made first of sole leather, and afterward of spring steel, or of a combination of these materials.

The *operative treatment* may consist in: (1) Tenotomy of peroneal tendons; (2) Tenotomy and forcible inversion with elevation of scaphoid; or, (3) Tarsectomy. In ordinary cases the best results are obtained by tenotomy of the peroneal tendons, followed by forcible inversion and elevation of the arch, with subsequent fixation by gypsum in the varus position for several weeks. The patient may then walk about upon the plaster cast, and afterward wear the shoe described above. In inveterate cases wedged-shaped excisions of the tarsus, with or without fixation by pegs, followed by careful support, will assist in locomotion.

CALCANEUS.—In cases where the tendo Achillis has become permanently lengthened, it should, under the most thorough aseptic precautions, be divided in an oblique direction, or slit and shortened the requisite amount to secure a normal position. The divided ends are then sutured with chromicized catgut or sterilized silk. The form of suture is of little importance, so that strangulation of tendon tissue is avoided. The wound is then closed and primary union secured. The foot should be dressed with plaster-of-Paris, so as fully to relax the calf muscles for three or four weeks.

An apparatus with stop joint and elastic assistant should be subsequently applied.

DEFORMITIES OF THE TOES.

HAMMER TOE, OR TALON TOE.—In Mr. Fisher's article it is said that certain authors who recommend division of the *extensor* tendon are mistaken. I have, however, on several occasions seen cases in which the deformity could not be relieved until the extensor as well as the flexor tendon had been divided, as the first phalanx would otherwise persist in assuming its former upright position.

The best method of maintaining the toes in the straight position after

[1] Roth, Lateral Curvature of the Spine, p. 55. London, 1889.

tenotomy is by passing an elastic ribbon or a tape through slots cut in an aluminium foot-plate, the dimensions of the slots being smaller than the ribbon. The latter is thus held in any desired position without knots. Stockings with toes are usually uncomfortable and expensive, and when the plate is used the tip of the hose should be removed.

HALLUX VALGUS.—As a result of inflammation of the metatarso-phalangeal joint, pus is not infrequently formed, and the end of the metatarsal bone may become carious, necessitating amputation. The toe may sometimes be retained in position by a sole-plate with an elastic ribbon run through a slot, as recommended in hammer toe; or a projecting arched septum may be placed between the first and second toes.

Osteotomy of the first metatarsal close to its anterior head permits the toe to be brought into good line, and often avoids the necessity for amputation. In suppurative cases, however, amputation is usually preferable, or excision of the metatarso-phalangeal joint may be substituted.

BOW-LEGS.

LATERAL CURVATURES OF THE LEGS.—These are usually remediable by apparatus and manipulation. Frequent and forcible manipulation is exceedingly important. Braces should be so constructed that pressure is made upon the apex of the curve, while counter-pressure is made at the inner malleolus and inner condyle.

Manual, Forcible, Immediate Straightening.—In young patients, when parents will not, or cannot, attend to the proper application of apparatus, immediate straightening by fracture over a smooth, wooden, half-cylindrical fulcrum is occasionally advisable. Sometimes a green-stick fracture results; more frequently straightening is accomplished without actual rupture of the bone fibres. Retention of the straight position is maintained by plaster-of-Paris for six weeks, and it is wise to support the limbs by apparatus until the condition of the child is such that there is no longer danger of recurrence.

The force must be applied suddenly, but judiciously, so that no injury to epiphyses will result. The compression is so momentary that sloughing never follows.

Osteoclasis.—Instrumental fracture by the osteoclast should only be employed when the bones are too strong for the manual power of the surgeon, and in America the operation is not so popular as osteotomy, since the exact point of fracture cannot be as readily secured, and the tissues are frequently so pulpefied that sloughing results; moreover, in the region of the joints the procedure is accompanied by considerable injury to the epiphyses.

Osteotomy.—A bone section made with a clean, sharp osteotome, or Adams's saw, through an aseptic wound which can be speedily closed, leaves for the surgeon only the treatment of simple fracture, and suppuration should be one of the rarest of results, unless a wedge has been removed. *Cuneiform osteotomy* is now only occasionally employed, since the wedged-shaped gap produced by the straightening of a bone after simple osteotomy readily fills with callus and a strong limb results.

ANTERIOR CURVES OF THE TIBULA AND FIBULA.—These seldom yield to apparatus, but with osteotomy excellent results may be obtained.[1] Even very angular projections may be straightened without removing a wedge. Drainage is seldom required. When it becomes necessary to remove a wedge, the piece may be chipped away or cut out with a chisel, but the operation should be avoided when possible. since the resulting compound fracture is a much more serious condition than the simple fracture which follows linear section. The use of an Esmarch bandage or tourniquet is not advisable, since the outflow of blood serves an excellent purpose in preventing the ingress of air. The dressings should be thoroughly aseptic, and they need not be removed as long as they remain sweet and clean. The best subsequent fixation splint is plaster-of-Paris, applied while the deformity is slightly over-corrected. In the process of fixation by a gypsum splint, it is desirable to enclose the fractured region with the first turns of the bandage, since the proper position of the limb can then be much better maintained by an assistant with a firm grasp upon the limb below and above the point of injury. A few moments will suffice to render these preliminary turns sufficiently rigid to prevent any displacement, after which the less essential portions above and below may be adjusted. Great care should be taken, while the cast is soft, not to make indentations by the fingers or otherwise, as each depression produces an elevation or mound upon the inner surface, which, when hardened, may give rise to great suffering or even to sloughing. Care should be taken to saw open and tighten the cast as shrinkage of the tissue occurs.

Operation with the Saw.—The osteotome is more frequently employed than the saw for section of a bone. While the use of the osteotome requires a larger wound of the soft tissues, and is not actually a subcutaneous operation, yet it is in many respects cleaner and more satisfactory, and is less liable to be followed by suppuration. Particles of sawdust, if they do not become incorporated and vitalized, may set up suppuration, acting as foreign bodies. The use of the saw is a slower and a more difficult operation, and if carelessly used the instrument will produce a certain amount of tearing of the soft tissues. The choice between these two modes of treatment will rest largely upon the experience of the operator.

GENU VALGUM.

Knock-knee, in common with the other deformities of rickets, is less frequently found in the United States than in Europe. It is essentially a disease of the poor of great cities. When knock-knee is combined with bow-leg and bowed femur, two or three sections may become necessary. Occasionally, especially in colored children, a peculiar cork-screw leg is produced by severe rickets. Frequent and forcible straightening by hand is the most effective measure. The supracondyloid osteotomy of Macewen, as described in Mr. Fisher's article in Vol. III., is so satisfactory in genu valgum that it has practically superseded all other procedures.

[1] International Clinics, Jan., 1892, p. 111.

Deformity of the Lower Extremities from Muscular Contraction.

Severe grades of muscular contracture frequently take place at the knee, hip, and ankle as a result of infantile paralysis, of spastic paralysis, hip-joint and ankle-joint disease, injuries, etc. These contractions are frequently so great as to place the limb mechanically in such a flexed position that walking would be impossible even were the muscles in their ordinary condition of strength and vigor. The straight position, therefore, becomes necessary. The deformity should be overcome by section of the contracted tissues, whether fasciæ, tendons, or muscles. In section in front of the hip, the tensor vaginæ femoris and the sartorius and rectus may be divided with perfect safety; but in severe grades, where the band is in close proximity to the anterior crural nerve, open division is safer. Under thorough aseptic precautions no suppuration will follow. Never should section of the iliacus and psoas be undertaken except by the open method. The adductors, as a rule, can be divided subcutaneously. Thorough attention should be given to strict cleanliness of the parts. At the knee, when the hamstring tendons alone are divided, the only care necessary is in regard to the external popliteal nerve, which may be felt upon the inner side of the biceps tendon. When, as is frequently the case, the fascia of the popliteal space is contracted, open incision with strict asepsis is the only safe method.

In the treatment following division of the adductors, it is impossible for any splint to hold the thighs apart unless the knees are fixed. A simple dressing of plaster-of-Paris fixes the knees, after which the limbs may be fastened wide apart until the gap in the adductors has been filled with fibrous tissue.

At the ankle and foot all contracted tissues are to be divided, following the rules indicated in the remarks on paralytic talipes.

By such simple operations many cases of contracture following the different forms of paralysis may be very greatly benefited, and patients long helpless may be restored to a good walking basis. At first it is impossible to do without artificial helps, such as braces, wheeled crutches,[1] and axillary crutches; but exercise will soon develop the muscles. While the shock of multiple tenotomies is considerable, yet the results to be secured justify the slight risks. In cerebral spastic palsy trephining the skull is indicated only in cases with decided cranial depression, especially when there is a history of traumatism at birth or afterward.

Bony deformities following joint disease may be corrected by forcible straightening, by osteotomy, or by excision.

Deformities of the Upper Extremities.

Division of the tendons of the upper extremities, at wrist, hand, or fingers, is rarely as successful as tenotomy in the lower extremities.

[1] Bradford and Lovett, Orthopædic Surgery, 1st ed., p. 59; Trans. Amer. Orthopædic Assoc., 1891, page 382.

WRIST DROP.—Shortening the tendons by open incision, splitting and stitching them, is desirable and safe under perfect asepsis. In severe flexion of the hand following paralysis, lengthening the tendons by open incision, splitting and resuturing, is sometimes advisable to give better mechanical position to the hand. Massage, electricity, and elongation of the muscles is often helpful in restoring the hand to usefulness.

Division of the contracted muscles by open incision directly through the fibres below the internal condyle has been practised, the arteries, veins, and nerves being carefully avoided. The hand is then dressed in the extended position and the gap becomes filled with fibrous tissue.

CLUB HAND.—Club hand is usually associated with other deformities, but is rarely double. The palmo-ulnar variety is the most common. When the deformity is moderate, it may be corrected by persistent manipulation, together with the employment of gypsum splints or mechanical devices. Tenotomy is seldom advisable, but open incision with splitting and splicing of shortened tendons, and shortening of the elongated ones, is advisable in serious cases when all other means have failed. Amputation should not be performed, as even a distorted hand is partially useful.

SUPERNUMERARY OR DEFICIENT FINGERS.—Supernumerary fingers, or polydactylism, is a condition that shows a remarkable hereditary tendency. The deformity is frequently double, and is often associated with a similar condition of the toes.

Treatment.—As operative interference is usually desired for cosmetic purposes, it should be instituted early. In boys, the utility of the part should be first considered. No absolute rules can be laid down, as the surgeon must be guided by the location, articulation, and degree of perfectness of each member, those of least value being sacrificed. Any remaining projecting portions of the metacarpal heads may be chiselled away. In one remarkable instance the amputated finger is said to have been reproduced twice.[1]

When there is a deficiency of fingers, plastic surgery will sometimes benefit the appearance of the hand; but amputation is not advisable, as even two misshapen fingers are very useful. In a case at present under my care, five last phalanges with perfect nails are joined, but not articulated, to the carpus.

Deformities of the *toes* need not be operated upon except when they give inconvenience or pain.

Hypertrophy of fingers or toes occasionally occurs, and is irremediable except by amputation. The whole nutrition of the fingers is increased,[2] but it does not appear to be a condition of acromegaly.

WEBBED FINGERS, OR SYNDACTYLISM.—Two or more of the fingers, or of the toes, may be joined at their bases or tips, or throughout their entire extent. Usually the bond consists only of skin and connective tissue, but in rare instances the bony phalanges are connected.

Treatment.—The difficulty in cure after division of the web arises

[1] C. White: On the Regeneration of Animal Substances.

[2] Journal of Mental and Nervous Disease, vol. xviii., 1893, p. 442.

from the tendency to readhesion which must always exist at the commissure. This is best corrected by cutting V-shaped or oval flaps, as advised by Agnew,[1] by dissecting flaps from the palmar and dorsal aspects of the web and suturing them across the cleft after division, or by raising longitudinal anterior and posterior flaps from separate fingers and suturing them in position after wrapping them around the raw incised surfaces (Didot). Should these procedures fail, a flap may be cut from the breast or thigh and turned into the cleft, the hand being firmly held by gypsum bandages until union has occurred, when the base of the flap may be cut away.

WRITER'S PALSY.—Scrivener's palsy is an example of want of co-ordination in muscular power which is seen in a variety of muscles, and is observed in many classes of artisans and mechanics when one set of muscles is obliged to constantly repeat a series of movements. It is not merely a local nerve exhaustion, but often indicates a disturbance of the central nervous system, and is a reflex neurosis.

The earliest symptom is muscular fatigue, followed by cramp and the want of co-ordinate movement. Numbness, tingling, and pain soon extend up the arm. The very earliest symptoms of this malady should induce the patient, if circumstances permit, to refrain from the use of the affected member, even placing it upon a splint or in a sling. Massage and electricity are not useful unless preceded by rest. Attention to the general health is of the utmost importance. For those who are unfortunately compelled to continue their avocations, and for temporary assistance, mechanical contrivances for holding the pen should be attached to the hand by means of rings and broad bands so as to relieve the muscles. The strong muscles of the forearm should be used for moving the pen instead of the weaker ones of the hand. The opposite hand should at once be systematically educated to take its proportion of work, a process which will be tedious of accomplishment, but which may be secured by perseverance.

DUPUYTREN'S CONTRACTION OF FINGERS.—This cicatricial-like contraction of the palmar fascia and of its digital prolongations condenses the subdermal tissues, but does not involve the true skin nor the tendons except in very old cases. In rheumatic families as many as three or four members may be similarly affected. Keen's tables[2] show that a majority of cases present a constitutional taint; but Abbe[3] favors the theory of traumatic and nervous origin.

Treatment.—Open division is more precise than multiple subcutaneous sections, and is no more painful. The hypodermic injection of cocaine, or local anæsthesia by the spray of chloride of ethyl, or the application of ice and salt, is sufficient to benumb the part. In open division the hand should be rendered bloodless for accuracy of section. One or more sections may be made, either diagonal, transverse, V-shaped, or oval, and the division should be so thorough that recontraction will not occur.

[1] Principles and Practice of Surgery, 2d ed., vol. iii., p. 372.
[2] Philadelphia Medical Times, March 11, 1882, p. 370.
[3] Med. Record, March 3, 1888.

Lateral Curvature of the Spine.

The literature of the causation of lateral curvature would fill volumes, and yet the true solution of the problem has not been reached. The arguments and conclusions brought forward in Mr. Fisher's article are still as forcible and convincing as they were when published, and no more rational theory has been promulgated.

It may still be said that while muscular debility, inequality in the length of the legs, inequality in the weight of the upper extremities, faulty positions of standing or sitting, neuroses, etc., are operative as causes, yet that many of these conditions exist in numerous instances without any deforming result. There must exist, therefore, in addition, a condition of ligaments, intervertebral discs, and bones—some deficiency of elasticity and flexibility—which, though undemonstrable by microscope or by chemistry, yet is certainly recognizable as a clinical fact.[1] Future knowledge will doubtless solve the problem. A discussion of these theories will be found in Young's work.[2] The theory of rotation as advanced by Mr. Fisher is still as rational as any that has been advocated, namely, that the posterior portions of the vertebræ, being firmly supported by numerous muscular and ligamentous attachments, are not easily influenced by the unequal forces brought to bear upon them, while the comparatively free anterior bodies of the vertebræ are easily swung from their position.

Treatment of Lateral Curvature.—The treatment of lateral curvature may consist of (1) Gymnastics, including Swedish movements and massage; (2) Mechanical measures to prevent and diminish the deformity; and (3) Forcible attempts to remove the rotation.

(1) *Gymnastics, etc.*—It is admitted by all orthopædic surgeons that increase of muscular power is an essential element in the prevention and cure of this distortion; consequently, well-regulated gymnastic movements should be a part of the education of all growing boys and girls. By this means the number of cases of lateral curvature will be very largely diminished.

As a means of cure, the systems of muscular movements employed are various. Each teacher of Swedish movements has individual, as well as general, views, and many of them are helpful. So with gymnastics: no one class of exercises should be alone relied upon. In general terms it may be said that the truncal muscles, especially upon the side of the convexity of the longest curve, are those requiring the most development. The surgeon should, however, decide in each individual case as to the necessities. This can best be done by observing the effect of certain groups of movements as demonstrated upon the bared back of the patient. That position and muscular action can affect the distorted chest and the rotated vertebral bodies, will be very evident if the surgeon grasps the pelvis of the patient and directs her to strongly rotate the upper portion of the body to right or left. This action will be especially noticeable if one arm is elevated alongside the head while

[1] Beeley, Trans. Amer. Orthopædic Assoc., 1891, p. 343.

[2] Orthopædic Surgery, p. 180, Philadelphia, 1894. See also Trans. Amer. Orthopædic Assoc., 1890.

the other is held at a right angle to the body; and still more, if with arms in the same position the trunk is flexed to a right angle with the thighs, and is then twisted to the right or left.

The muscular movements that can be practised by the patient at home are exercises on a chest weight, with pulleys lowered to the floor so as to cause flexion and development of the posterior muscles; horizontal bar; trapeze or rings; dumb-bells, clubs, and self-suspension by head and arms, the hand upon the side of the concavity of the curve being placed uppermost on the rope.

Other home exercises may be the various forms of Swedish movements; lying upon the abdomen with head and shoulders raised without assistance of the hands; lying with the body projecting over the edge of the table while the pelvis is held in position, etc.

Horseback exercise (riding astride), rowing with both hands—or if with one hand using that on the debilitated side—tennis or croquet played with the hand on the concave side of the larger curve, swimming and other sports, are all beneficial if followed by a period of rest in the supine or prone position upon a flat couch. It is advisable that patients with lateral curvature should sit or stand but little; they should either walk or lie flat; in fact, recumbency should be insisted upon as an essential element of the treatment. Massage is helpful in connection with Swedish movements, and forcible manipulation will accomplish much. It is especially important that the *backward* and *lateral* flexibility of the spine should be increased.

Under the direction of a surgeon, or of a teacher, the postural movements advised by Roth,[1] Sayre,[2] Bradford,[3] Taylor,[4] and others, may be employed with advantage. The patient should also be instructed in proper methods of sitting, lying, etc., a flat couch being the best for the supine position. A light book carried upon the head helps to secure a good carriage.

(2) *Mechanical Appliances.*—Mechanical devices for lateral curvature have been invented by the score, but most of them are useless. Except when the spine is rapidly bending it does not need support; muscles require strengthening, not weakening. However, supports are occasionally necessary. Of the fixation or jacket supports, the appliance of Bartow is the most rational in cases of moderate deformity, since its action tends always to produce a normal conformation of figure. It is made by taking a plaster cast of the trunk while in a state of suspension, from which cast a counter cast or model is afterwards secured. This is then remodelled by paring away all abnormal projections and filling in with soft plaster all depressed portions, until the representation of a normal figure is secured. Upon this more or less perfect model a leather jacket is fitted, which, when hardened, is adjusted to the patient's trunk.

A plaster jacket is sometimes employed, though harmfully, unless pieces are cut out of it from time to time and straightening thus accomplished, or unless it is applied under forcible restitution, effected in one of the methods described below.

[1] Bernard Roth, Lateral Curvature, p. 24. London, 1889.
[2] Medical Record, Nov. 17, 1888, p. 538.
[3] Bradford and Lovett, Orthopædic Surgery, p. 160. 1890.
[4] Trans. Amer. Orthopædic Assoc., 1890, vol iii., p. 136.

Rigid forms of apparatus, made of steel and webbing, are numerous.[1] They aim to make pressure upon the projecting ribs, while a crutch-head assists in elevating the depressed axilla. The effect that they produce is slight, but they are useful as reminders to the patient that the erect posture must be maintained. Shaffer's instrument is light and convenient. When rapid increase of deformity is taking place, it is sometimes necessary to employ one of these means of support until gymnastics, etc., can restore sufficient muscular power to enable the body to maintain its equilibrium. The corsets of thick, heavy webbing sometimes used are very objectionable.

Beeley[2] has drawn attention to a most important point in the construction of spinal apparatus, by insisting upon the careful and accurate fitting of the pelvic band.

(3) *Forcible Restitution.*—Many efforts have been made from early periods to replace the distorted portions of the trunk, and these methods have recently been resuscitated. Adjustable pads and levers, placed against the projecting ribs while the pelvis and shoulders were secured, have long been in use. Present plans include forcible bending of the body over a fulcrum, either a strap or a fixed body; forcible twisting by the appliances of Brackett,[3] Weigel,[4] Schede,[5] Lorenz, Hoffa,[6] and others, the patient being erect or suspended; or heavy-weighting of the projecting parts while the patient is in a stooping position, as in Beeley's apparatus. The weights upon the straps in the latter appliance may be fifty or sixty pounds, and should be continued as long as they can be tolerated by the patient. Many of the instruments above alluded to are regulated by adjustable screws and pads, and are troublesome and expensive. To restore the rotated bodies of the vertebræ is still an uncertain procedure, although a certain amount of gain may be accomplished.

TORTICOLLIS.

Much of the difference of opinion between authors is explained by the fact that they have failed to distinguish spasmodic and intermittent wry-neck from structural shortening of the muscles. The latter is a condition which ordinarily may be permanently relieved by myotomy with subsequent massage and gymnastics of the muscles; the former is a most troublesome and intractable disease which resists all forms of treatment, and which appears to depend upon a central nerve lesion.

In the intermittent variety the distress is often excessive from the involuntary painful contraction interfering even with sleep. The seat of the disease lies in the cord, at the root of the spinal accessory or upper spinal nerves, or from some lesion along their course. The most common causes are local traumatism, sudden nervous shock, direct effect of cold, and some constitutional diseases, such as rheumatism. Ordinarily adults are affected.

Diagnosis.—The diagnosis of wry-neck from cases of cervical spinal

[1] Bradford and Lovett, op. cit., 1890, p. 165.
[2] Trans. Amer. Orthopædic Assoc., 1891.
[3] Boston Med. and Surg. Journal, May 11, 1893.
[4] Trans. Amer. Orthopædic Assoc., 1893, vol. vi., p. 265.
[5] Deutsche med. Wochenschrift, 1892, Bd. xviii., S. 249.
[6] Zeitschrift für orthop. Chirurg., 1891.

caries is occasionally confusing at first examination, but is cleared up by closely watching the symptoms. Hysterical contractions also are often perplexing. Torticollis from injury of the sterno-mastoid during birth is not uncommon,[1] and hæmatoma of the muscles should be closely watched for some time after birth.

Treatment of Wry-Neck.—For the spasmodic variety, gelsemium carried to the point of constitutional poisoning has been lauded by Sinkler and others; deep injections of chloroform, strychnia, atropia, morphia, etc., have all been employed with varying degrees of benefit; electricity and massage have cured a few cases; arsenic and belladonna, and scores of other drugs, have met with temporary success. Myotomy of the sterno-mastoid is seldom sufficient in these spasmodic cases, even though performed by the complete open method, since the scaleni, trapezius, complexus, and even the splenius and rotators, may be involved. For the simple cases, the drugs and measures already enumerated, with manipulations and the use of apparatus, are sufficient to effect a cure, and the prognosis in a large proportion of acute cases is favorable. Cases of structural shortening will usually require myotomy, while those of the intermittent variety not infrequently resist medication, myotomy, neurotomy, neurectasy, and even neurectomy. Young, Lovett,[2] and others have shown that there is sometimes a curious relation between ocular defects and torticollis.

Permanent contractions of the sterno-mastoid are remediable by myotomy of the sternal or clavicular divisions, or both; and in severe cases by a similar section of the mastoid insertion. While open section under antiseptic precautions is the safer procedure, yet in females, in order to avoid a scar, the slight amount of risk involved by subcutaneous division is justifiable in mild cases. If a blunt-pointed tenotome is carefully carried close behind the rigid muscle, accident can scarcely occur. I have once only seen death occur, from septic pleurisy, when in the hands of a most dexterous operator an unusually high pleura was punctured.

A very simple, but effective, dressing after myotomy consists of an axillary or thoracic belt, and a head bandage, the two connected by a rubber strap.

Neurectomy.—The first excision of the spinal accessory nerve was performed in 1866 by Campbell de Morgan.[3] He made his incision at the posterior border of the muscle, and having found the trapezial branch traced it back until the main trunk was visible. Noble Smith[4] has collected much valuable material in regard to this operation, and Bowlby[5] relates a number of cases; Smith employs an incision anterior to the sterno-mastoid, as it permits a more certain division of all the nerve filaments. Simple neurotomy is not advisable, since even the removal of a half-inch of nerve has been non-productive of relief. A certain amount of atrophy and paralysis must necessarily follow an excision.

The centre of either an anterior or a posterior incision should be about opposite the upper border of the thyroid cartilage, or a little above the

[1] Trans. Amer. Orthopædic Assoc., 1891, p. 30.
[2] Ibid., vol. i., p. 46; vol. ii., p. 230.
[3] Brit. and For. Med. Chir. Review, vol. xxxviii., 1866.
[4] Spasmodic Wry-neck, p. 55. London, 1891.
[5] Injuries and Diseases of the Nerves. 1893.

middle of the sterno-mastoid muscle. It is not always easy to find the spinal accessory, but it should be remembered, that it runs diagonally from the inner and upper angle to the outer and lower angle of a parallelogram formed by two horizontal lines drawn, one from the angle of the jaw, the other parallel to the first, from the border of the thyroid cartilage. These lines with the anterior and posterior borders of the sterno-mastoid form a parallelogram. The nerve enters the muscle about two inches below the mastoid.

Ligation of the Nerve.—Mayo Collier [1] applied a tight wire ligature to the spinal accessory, with permanent relief from the spasmodic movements; but it is difficult to see that this method could be as safe as neurectomy.

Neurectasy, or Nerve-Stretching.—The spinal accessory may be reached by an anterior incision downward from the lobe of the ear, by which the digastric and stylo-hyoid muscles will be exposed; the nerve may be hooked up and stretched between these and the sterno-mastoid, but it should be remembered that strong traction must necessarily influence the medulla. The nerve may also be reached at the posterior border of the sterno-mastoid.

The results of this operation are usually unsatisfactory, and neurectomy is preferable.

Resection of the Posterior Cervical Nerves.—These nerves may be reached by a three-inch incision parallel to, and an inch outside of, the spinous processes, cutting through the trapezius, the edge of the splenius, and the complexus. When the nerves are reached, all the fibres should be excised for at least a third of an inch. The suboccipital is difficult of access. The resultant muscular paralysis is not considerable, but wasting must necessarily occur.

Keen [2] made his incision transversely, three inches long diagonally across from the spine to a half inch below the lobe of the ear, dividing the trapezius and the complexus, but avoiding the great occipital nerve. The posterior division of the second cervical was first exsected, then the suboccipital. The external border of the posterior division of the third was exposed below the great occipital, and excised. By this means the nerves supplying the chief external rotators of the head, that is, the splenius, the rectus capitis major, and the obliquus inferior, were cut off.

An electric forehead-light will greatly facilitate the speed of the operation.

Congenital Malformations of the Hip.

The condition commonly known as congenital dislocation is much better described as a malformation of the acetabulum, or femoral head and neck, or both. Many variations of malformation are met with, most of which are due to the misshapen head and neck of the femur. These cases are accompanied by more or less sliding motion at the hip, according to the degree of deformity in the acetabulum, and the patients have a waddling gait to a greater or less extent. . In a number of cases heredity is easily traceable. Not infrequently a history of

[1] Lancet, June 21, 1890.

[2] Annals of Surgery, Jan., 1891.

violence during delivery, in a foot presentation, is obtainable. Occasionally an anterior displacement is encountered.

The plan of long-continued extension, as practised by Dr. Buckminster Brown, consumes so much time and requires such absolute control of the patient that it will seldom succeed. Prolonged extension, however, for six months or a year, is essential so as to bring the femoral head well into position before resorting to mechanical measures. Bradford [1] has devised an apparatus which permits continuous extension both in the supine and in the sitting position.

Mechanical Appliances.—A wide waist and pelvic band, made of leather and fitted accurately over a plaster cast of body and thighs, with locking and unlocking hip-joint, is useful.[2] A long Taylor or other extension hip splint is, after extension in bed, most helpful, and subsequently a walking splint should be worn.

Operative Measures.—The most favorable cases for operation are those in which the bone is freely movable. Hoffa's [3] plan of procedure is to free the trochanter from all the retaining muscles, bring the head of the bone forcibly downward and forward into its normal site, and excavate the rudimentary acetabulum as deeply as the thickness of the ilium will permit. The saving of the head is an important element.[4]

In the discussion upon this subject before the German Surgical Society, Hoffa said that the operation should be performed between the third and sixth years, as the head and neck of the femur afterward become altered, and it is then impossible to draw the head down to its normal site.

When the deformity is double, the ligamentum teres is usually absent, causing a slip, or sound, on rotation, in which case an operation is undesirable. The consensus of opinion is not in favor of operative over mechanical methods.

CONGENITAL ABSENCE OR DEFICIENCY OF BONES.

The bones of the *lower extremities* are more commonly absent than are those of other portions of the body. The cause may be inferred to be the same influences of position, etc., that make club-foot much more frequent than club-hand. Occasionally all the extremities are absent, the trunk alone being present. More frequently one extremity is absent, or so dwarfed, distorted, and misshapen that its components are barely recognizable. The head and neck of the femur may be distorted, or a large portion of the shaft may be missing, the thighs being much shortened; in one case under my care, the distance from perineum to knee was less than an inch. Congenital crural asymmetry is not uncommon, the difference in length of the thighs sometimes amounting to an inch or more. Tilting of the pelvis is common in these cases, but lateral curvature only occasionally results.[5] The fibula is occasionally absent, or it may be represented merely by a band of tissue.

[1] Trans. Amer. Orthopædic Assoc., 1891, p. 308. [2] Phila. Med. Times, Nov., 1880.
[3] Trans. Twenty-third Congress German Surgical Society, April 18, 1894; Jour. Amer. Med. Assoc., July 21, 1894.
[4] Trans. Amer. Orthopædic Assoc., 1891, vol. iv., p. 139.
[5] Centralblatt für Orthop. Chirurg., Juli. 1885; Trans. Amer. Orthop. Assoc., 1891, p. 15.

The *upper extremities* are sometimes so shortened and misshapen as to bear a resemblance to fins. The radius and ulna may be bent or absent, and congenital defects of the fingers are not rare. The most common deficiencies are where two or more fingers are consolidated into one, or where some fingers are entirely absent. In these cases there are usually associated deformities in other portions of the body.

While these bony defects are irremediable in themselves, yet surgery can frequently lessen the deformity and greatly assist in facilitating locomotion. Subcutaneous or open myotomies and tenotomies, osteotomies, etc., with or without subsequent employment of apparatus, will accomplish much, and plastic surgery will often be helpful.

INJURIES OF THE HEAD.

BY

CHARLES B. NANCREDE, A.M., M.D.,

PROFESSOR OF SURGERY AND OF CLINICAL SURGERY IN THE UNIVERSITY OF MICHIGAN, EMERITUS PROFESSOR OF GENERAL AND ORTHOPÆDIC SURGERY IN THE PHILADELPHIA POLYCLINIC, ETC.

TREATMENT OF SCALP WOUNDS.

AN insignificant scalp wound, *if it become infected*, may lead to periostitis, purulent osteitis, osteophlebitis, and encephalitis; or, again, from the periosteum the infective process may, by continuity of tissue, through osteophlebitis, initiate thrombosis of the cerebral sinuses, with consequent pyæmia. While this is an uncommon, it is a possible, complication, and treatment should aim to prevent this as well as tetanus. The necessary precautions to this end, about to be detailed, are equally necessary prerequisites to trephining for disease or injury, and will not be repeated when dealing with those subjects. As scalp wounds often lead directly down to unsuspected and severe lesions of the skull and brain, no precautions should be viewed as being too troublesome.

First drench the parts with carbolized water,[1] cut with scissors or, better when possible, shave all hair from the edges[2] and immediate neighborhood of the wound, and scrub the scalp with a nail-brush wet with dilute acetic acid one part, alcohol seven parts.[3] This in turn should be removed with abundance of sterilized water and green soap containing 5 per cent. of hydro-naphthol. Finally, thorough irrigation with mercuric chloride solution should precede the examination of the wound by the disinfected finger. If any doubt exists as to bone injury, the scalp wound should be enlarged. A strictly aseptic or antiseptic dressing should finally be applied, and with this addition the advice given in my article in Vol. V. still holds good. As antisepsis would be hard to secure, the employment of the hair to coaptate scalp wounds recommended in that article should not be attempted. The modified commendation of sutures there given should be extended to the advice to employ them in all cases when requisite, when an aseptic condition of the wound can be secured. Of course, here and elsewhere, the

[1] Boiled water should be used for the solution, and when no antiseptic is obtainable is infinitely better than unboiled water, being at least *aseptic*.

[2] If operating for brain tumor or epilepsy the whole scalp should be shaved.

[3] This serves to remove all greasy substances, at the same time acting as a germicide, but ether will do; if preparing for an intracranial operation for disease, after the preliminary shaving some surgeons employ a soft-soap poultice for a short time, followed by the application of an antiseptic dressing for twenty-four hours before operation; this latter expedient should always be adopted in cases of epilepsy and brain tumor.

crude method of employing lint wet with a bichloride solution should be discarded for the more efficient methods now in vogue.[1]

Treatment of Phlegmonous Erysipelas of the Scalp.

Under no circumstances should my former advice be taken, to apply poultices after opening pus collections, a moist antiseptic dressing, covered with rubber tissue or some substance impermeable to moisture, being invariably to be employed, the incisions being made after the preliminary preparation of the parts just advocated.

Trephining.

Preparation for Trephining.—In addition to what has just been advised, when demanded by the nature of the case, the cerebral fissures should be marked on the scalp with an aniline pencil or nitrate of silver point, after the preliminary cleansing, when a moist antiseptic dressing covered with cotton wool and oiled silk should be secured in place, only to be removed after the patient is anæsthetized. When time permits all this should be done at least twenty-four hours before operation. When done for epilepsy, tumor, etc., that is, where no scalp wound exists, a soft-soap poultice may be kept on for a few hours after, or instead of, the alcohol and acetic acid wash. Slight elevation of the head, or the semi-recumbent position, is the best for operation, because lessening the hemorrhage. When this is specially to be avoided, as in children, the Esmarch tourniquet may be applied; if it does not succeed, as is frequently the case, the vessels should be secured by needles armed with catgut passed through the scalp beneath them, or by catch-forceps. The bone should be marked with a drill or the centre-pin of the trephine, removed for the purpose, at the upper and lower extremities of the Rolandic fissure, before the flap is cut. The flap, including the periosteum, should be large, with a semilunar or horseshoe outline, its base so disposed as to contain the chief scalp-vessels. The hemorrhage being controlled, the bone is removed by trephine or chisel as seems best.[2] Bleeding from the large diploic veins may be arrested by concentrically crushing in the surrounding bone with some blunt instrument, or by plugging with a bone chip, or with antiseptic wax. I have recently resorted to temporary plugging with fragments of antiseptic gauze or with an aseptic match-stick. Special precautions must be observed when both walls of the frontal sinus are broken. Most thorough disinfection of the sinus should precede perforation of its posterior wall, and at the conclusion of the operation the cavity must be carefully tamponed with iodoform gauze, remembering that symptoms of secondary compression may result from swelling of the tampon, by imbibition of wound fluids. The orbital margin should be resected, if necessary, to remove infected bone or foreign bodies.

Should the dura mater require incision, a point is raised about one-

[1] While I usually employ bichloride of mercury, it is hardly requisite to say that any other efficient germicidal or germ-inhibiting substance may be used instead.

[2] When the fragments are to be replaced, they must be kept in a warm antiseptic towel, or sponges, or solution, until needed.

fourth of an inch from the margin of the opening with mouse-toothed forceps, a small opening is made with the knife, and the incision—which must include only about four-fifths of the circumference—is completed with blunt-pointed scissors; in this way the large veins of the pia mater will escape injury. After the dura mater has been reached, nothing but boiled water should be used for irrigation, because possibly dangerous[1] and certainly interfering with the localization of nerve centres by the faradic current. Vessels of any size, crossing the proposed line of incision of the dura mater, should be first secured by passing beneath them—through the dura—a curved needle armed with a fine catgut ligature. Wounded vessels of the pia mater must be secured by gently tying with fine catgut, the first half of the knot being drawn only tight enough to occlude the lumen of the vessel, as the walls are very frangible. When this plan fails, small wire serre-fines,[2] to which fine silk threads are tied, may be left for forty-eight hours, or until they spontaneously separate. Gauze packing cannot be relied upon as a permanent measure for arresting serious bleeding from either the pia mater or the brain substance, although efficient for oozing from the small vessels of the latter; irrigation with hot water, or sponge pressure, will, however, usually suffice for this.

A wounded sinus must be promptly compressed, ligated laterally, the opening plugged with a bunch of catgut, or the whole channel included between two ligatures placed on each side of the wound by means of a curved needle; antiseptic tamponnade is all that I have employed myself or seen employed, the plug being cautiously removed at the end of about forty-eight hours.[3]

When the operation has been completed the dura mater must be carefully sutured with fine catgut, a piece of pericranium[4] being substituted for this membrane if it has been removed, or a piece of dentist's heavy gold foil[5] being slipped beneath the margins of the osseous opening so as to repress any tendency to brain protrusion. This last measure has been suggested in trephining for epilepsy to prevent the formation of adhesions between the scalp and the brain or its membranes.

If thought best the bone fragments may be replaced, or the minced-up fragments may be strewn over the membranes when these are intact. Only large fragments, perforated and secured by catgut to the scalp flap, are permissible if large openings in the dura mater exist. Plates of decalcified bone, or celluloid,[6] cut to fit the opening, but having a notch at one side for drainage, have been employed to fill up bony defects; but these measures are of questionable value, excepting where the opening is exceedingly large or peculiarly situated.

The question of drainage here arises. Unquestionably when an expert in brain work is operating for epilepsy or brain tumor, in most instances no drainage will be requisite, but for the average operator I consider the following rules to be the safest. I must here trench—as I have done in my preceding remarks—upon the province occupied by the supplementary article of Dr. Keen, but it seems to be unavoidable.

[1] Some recent experiments seem to prove this.
[2] Ordinary hæmostatic forceps are too heavy.
[3] See Park's cases, Med. News, Dec. 3 and 10, 1892, page 16. [4] Keen.
[5] Bradford; Park, Clinical Contributions to the Subject of Brain Surgery, reprint from Med. News, Dec. 3, 10, 1892, p. 20.
[6] Von Eiselberg. Verh. der Deutsch. Gesell. für Chirurg., XX. Congress, 1891.

In operations for epilepsy, for insanity,[1] or for fractures where no serious lesion of the dura exists, and asepsis has been secured, capillary drainage, preferably by catgut, may be employed. Where large bone fragments have been replaced, only capillary drainage is available. In compound fractures with lesions of the dura, where there is doubt as to the attainment of perfect asepsis, tube drainage had better be employed for forty-eight hours. Tube drainage is always indicated for abscess.[2] Prompt union of the flap should be secured by accurate coaptation with medium-sized interrupted silk sutures, placed one-third of an inch apart, with intermediate stitches of fine silk or horsehair. If capillary drainage be used, the threads must be kept parallel, in close contact, and cut off square, and the protective must extend some distance beyond their ends. Tube drainage should not be kept up, except for pus, beyond twenty-four hours.

With an experienced operator Horsley's plan is probably safe, viz., accurate suturing of the whole line of incision except for about an inch at the most dependent point, "where any tension of wound discharges can relieve itself by escape between the edges," but capillary drainage is safe, effective, and should always be employed when in doubt. The primary voluminous antiseptic dressing must be carefully renewed so as to make gentle pressure over the centre of the flap at the end of twenty-four hours, if tube drainage has been employed, since this should then be dispensed with; otherwise the dressing need not be disturbed, unless the symptoms indicate retention of discharges, when they must be given vent by means of a sterilized probe gently introduced along the track of the drainage-tube, or between the stitches if no drainage has been used.[3] After from five to seven days I have usually removed the stitches, supporting the flap with gauze strips and collodion, and applying a boric acid and cotton dressing instead of the antiseptic gauze.

TEMPORARY RESECTION OF THE CRANIAL WALL AS A SUBSTITUTE FOR TREPHINING.—The soft parts are incised down to the periosteum in the form of the Greek omega, and allowed to retract; the periosteum is divided close to the border of the flap, the bone is chiselled through along the line of the periosteal incision, and the bridge of bone at the base of the omega is divided subcutaneously with a narrow chisel; the osteo-cutaneous flap is then lifted up with elevators and replaced after completion of the operation. Specially constructed chisels have been recommended, but ordinary narrow bone-chisels will suffice in careful hands.

USE OF THE CHISEL INSTEAD OF THE TREPHINE.—This instrument is preferred by Mr. Chiene and by many German and American operators. Unquestionably for the cutting out of cracks it is preferable to any other instrument, and doubtless in experienced hands is as safe, or safer, for perforating the cranium than a trephine; but for the average operator the trephine is, in my opinion, the better instrument.

[1] See Park, op. cit., for cases where drainage was dispensed with.

[2] Iodoform gauze is employed for drainage by some operators. Unless hemorrhage is to be controlled by the pressure I can see no advantage in this, and some disadvantages.

[3] See Horsley's papers as to the advantages accruing from this liquid compression, which serves to repress the tendency to hernia cerebri and prevents firm cicatricial adhesion between the flap and the membranes, or the brain.

OSTEOPLASTIC RESECTION OF THE CRANIUM.—Defects left by injury or disease may be repaired by removal of the cicatrix, freshening the bone edges, and transplanting, from the contiguous parts, a properly shaped flap consisting of skin, periosteum, and the outer table of the skull; the wound left by removal of the flap may be covered with skin-grafts after Thiersch's method.[1]

MORTALITY AFTER TREPHINING.—Wagner and Seydel give statistics showing that by an immediate resort to trephining the mortality varies from 1.23 per cent[2] for recent accidents, to 1.6 per cent.[3] for epilepsy, brain tumors, etc.; when compound fractures are not operated upon until after the lapse of twenty-four hours, or more, the mortality rises to 33.33 per cent.

INDICATIONS FOR TREPHINING.—In compound fractures, the surgeon should always operate, not for compression, but in order to disinfect. This can only be properly done by elevation of fragments, or even their removal, to admit of paring with a chisel to get rid of dirt, and of free antiseptic irrigation. The slightest fissure,[4] as by imprisoning a hair, has been the starting-point of sepsis; so that where there is the slightest doubt, all cracks should be carefully chiselled out and thoroughly disinfected. Lacerations of the dura mater should be repaired by suture. The form of flap must depend somewhat upon the original wound, but it should be large, to repress any tendency to hernia cerebri.

Should simple fractures be trephined? Bearing in mind the immediate risks of encephalitis, and the future ones of epilepsy and insanity, there can be but one opinion as to the advisability of operating for all varieties of accessible fracture. An exploratory incision, made with strict antiseptic precautions, will resolve any doubt in cases of head-injury, and if no bone lesion be found will heal promptly, adding nothing to the risks.

TREPHINING IN FRACTURES OF THE BASE.—When accessible these should receive the same treatment, the chief objects of operation being disinfection and drainage,[5] and but rarely elevation of fragments.[6]

AFTER-TREATMENT OF TREPHINING.—Liquid diet is to be recommended for the first three days, but this is often productive of furred tongue with an unpleasant condition of the mouth; the use of a tooth-brush wet with a saturated solution of chlorate of potassium will usually give relief. In comparatively slight cases of operation, for epilepsy, etc., the patient may get up in a week, and be allowed solid food as soon as he desires it, while in more severe cases, especially where much bone has been removed, and particularly where the brain has been compromised, he should not get up until some time in the third week.

[1] Schönborn, J. Wolf. Verhandl. der Deutsch. Gesellsch. für Chirurg., XX. Congress, 1891.

[2] W. Wagner (Königshütte). Volkmann's Sammlung klinischer Vorträge, Nos. 271, 272; Chirurg. No. 85, 20 April, 1886.

[3] Antiseptik und Trepanation, von K. Seydel. München, 1886.

[4] See author's case reported to Phila. Co. Med. Society, May 8, 1889.

[5] See Allis, Annals of Surgery, vol. x. Warren, Amer. Journ. Med. Sciences, vol. xcix.

[6] See article in Vol. V. for case where this was necessary.

Attention to the bowels, and the use of the cold-water coil or ice-bag for headache, high temperature, or incipient encephalitis, may also be requisite.

While I have never seen anything but good done by low diet and local bleeding with the internal use of calomel, and while I believe that thereby in many cases incipient stasis in the cerebral vessels of the inflamed area is obviated, thus preventing the accumulation of germs which overcome the resistance of the tissues, yet the injudicious use of such means may be prejudicial to the patient. Knowing as we do that diffused (septic) meningitis with open wounds results from infection through the wound, or by germs in the circulation—harmless while few in number, yet capable of fatal mischief if allowed to accumulate at any point—I cannot but think that, in injuries where no external invasion atrium exists, the mechanism of intracranial suppuration is that which I have given, and that the therapeusis suggested is the proper one. If this be true, suppuration cannot be induced by the lowered resistance of the tissues induced by a few days' diminution of nutriment, while this may, and often does, in conjunction with the use of the drugs mentioned,[1] prevent such a slowing or stasis of the cerebral circulation as might admit of the accumulation of germs in dangerous numbers at the injured point. It is quite probable also that intestinal sepsis is obviated by such a germicidal substance as calomel, and while unproved, it is possible that the prolonged employment of mercury may inhibit the development of germs in the circulating fluid, thus explaining the clinical fact that this drug exercises a beneficial influence in various inflammations.

Treatment of Contusions of Bone.

I must still most emphatically recommend operation when the local symptoms indicate the presence of osteomyelitis, not primarily for the evacuation of subcranial pus, but in order to freely remove the infected bone; this, when promptly done, is the only effectual means at our disposal for preventing osteophlebitis, subcranial suppuration, or pyæmia. This measure has been successfully employed where bone trouble, initiated by old ear disease, has caused septic thrombosis of the lateral sinus,[2] this channel having been cleaned out and disinfected after complete removal of all infected bone and ligation of the internal jugular vein.[3] I would therefore add to the words in my former article,[4] "What if no pus between the dura mater and bone be found?" "Proceed at once to remove all infected bone well into healthy tissue, thoroughly disinfect, and drain." The same remarks apply to the statement[5] that "nothing more can be done surgically than to evacuate pus wherever accessible, etc.," for possibly removal of affected bone and ligation of the jugular vein may save lives in the future as it has done in the past. Too much attention cannot be paid to the condition of the kidneys and intestines, which eliminate not only large amounts

[1] See Vol. V.
[2] Med. Press and Circular, p. 495, 1886. Other cases have since been reported.
[3] Macewen, Diseases of Brain and Spinal Cord.
[4] Vol. V., page 11. [5] Ibid., page 13.

of ptomaines, but certainly, in the case of the former organs, even germs themselves.[1]

When explaining "Teevan's law" in my former article, it was not also mentioned that splintering is in inverse ratio to momentum, and that much diminution of the fracturing force is effected by its transmission through the different layers of the skull, which are of varying density; this helps to explain the extensive shattering of the internal table.

Basal Fractures.

Prognosis.—Where there are only non-fatal intracranial lesions complicating the fracture, provided septic meningitis and cerebritis can be prevented, a large percentage of recoveries takes place: thus Wagner reports that twenty-three consecutive cases, that is, all in which the patients survived their injuries more than forty-eight hours, terminated favorably.[2]

Treatment.—If the line of fracture traverse the petrous portion of the temporal bone,[3] the external auditory meatus must be carefully cleansed, all cerumen, dust, or blood being removed, after which careful irrigation with warm mercuric-chloride solution (1–2000) should be employed, or hydrogen peroxide may be injected, or the use of the latter may precede that of the former; when thorough disinfection has been accomplished, an antiseptic gauze dressing must be secured over the ear. Where the vault of the pharynx or roof of the nasal cavities is implicated by the fracture, these cavities must be cleansed, first by a hot boric-acid solution, employing for this purpose the posterior nasal syringe, or the same thing may be effected by prolonged spraying of the nose and pharynx. Solutions of thymol, various proportions (1 to 2, 3, or 4) of listerine and water, or boro-salicylic solution, may be used at the onset instead of the boric-acid solution, and some one of them must be employed afterward as often as once every two or four hours. After cleansing, boric acid or safe amounts of sterilized iodoform may be insufflated into the naso-pharynx, while the nostrils must be lightly plugged with loose rolls of some variety of antiseptic gauze.[4] In accessible portions of the base, as some portions of the occipital and temporal bones, and the orbital plate of the frontal bone, operative interference may, in suitable cases, render valuable service by effecting drainage, and by affording a better opportunity for disinfection.[5]

The recent suggestion to immobilize the fragments by a plaster-of-Paris cap has not as yet been carried into practice, and would seem to be of too little practical value to warrant the annoyance and the interference with other measures which it would entail.

[1] This statement has been as positively denied as asserted.

[2] W. Wagner (Königshütte), op. cit.

[3] J. C. Warren contends that a blow on the ear will fracture the base, the fissure passing along the upper wall of the auditory meatus, the petrous bone being weakened by its foramen; he has demonstrated this upon the cadaver.

[4] Of course such attempts at asepsis are only approximately successful, but (Wagner, op. cit.) even partial asepsis has markedly lowered the mortality of these cases.

[5] Punctured wounds of the orbit must be so treated, by enlarging the opening, disinfecting, and introducing a drainage tube. See also Allis, loc. cit.; Warren, loc. cit.

Intracranial Hemorrhage.

Extra-Dural (Subcranial) Hemorrhage.—In addition to what I have urged in my previous article, I must again call attention to the fact that symptoms of pressure may be delayed for many days—even eleven—after the injury.[1] This may be due to a renewed hemorrhage, or to the sudden yielding of brain function so often seen after long-persisting hemorrhagic or serous effusion, although no appreciable addition to the pressure occurs. The peculiarities of the hemiplegia met with in these cases are that at the onset it is partial, affecting perhaps only one centre, and that it progresses always by attacking adjacent centres either above or below that primarily implicated. Thus the arm may be first involved, next the leg, and then, as the blood gravitates, the face may become affected, until finally, when the base is reached, the third nerve becomes first irritated and then paralyzed, producing the well-known pupillary symptoms.

Moreover, when the patient is in a condition for it to be demonstrated, there is no sensory paralysis, this at once distinguishing the lesion from an apoplectic one, or from hemorrhage into the brain substance, the result of laceration. Ferrier says that "strictly cortical lesions of the motor area do not cause anæsthesia in any form, and it may be laid down as a rule, to which there are no exceptions, that if anæsthesia is found along with the motor paralysis, the lesion is not limited to the motor zone, but implicates also, organically or functionally, the sensory tracts of the internal capsule or the centres to which they are distributed." The practical bearing of the above sentences is admirably illustrated by a case of Mr. W. Thornley Stoker, from whose article I have transcribed the quotation.[2]

While the respiration is slow, stertorous, and, perhaps, very irregular, the pulse, although possibly slow at first, afterward becomes frequent, the result of indirect pressure producing paralysis of the vagus. The temperature is usually elevated, sometimes reaching 104° F., especially on the side opposite the clot.

Treatment.—To emphasize what was urged in Vol. V., a mere presentation of the statistics of Weisemann is only requisite, these showing such vastly better results than I could demonstrate by my former statistics, that the position then taken is amply justified. Thus of 147 patients treated without operation, 131, that is, 89.1 per cent., died, while of 110 who were trephined, only 36, that is, 32.7 per cent., died, and in the fatal cases the autopsy demonstrated that if another opening had been made, the clot might have been reached and removed, and some probably would have recovered.[3] These results have been obtained (1) by prompt operation, (2) by improved technique, and (3) by asepsis and drainage.

Operation.—Although the clot is usually situated upon the side of injury, the trephine opening must not therefore necessarily be made there, unless the localizing symptoms warrant this site being selected;

[1] Ransohoff reports a case where no symptoms appeared until the morning of the eighth day. Annals of Surgery, vol. xii., p. 116.

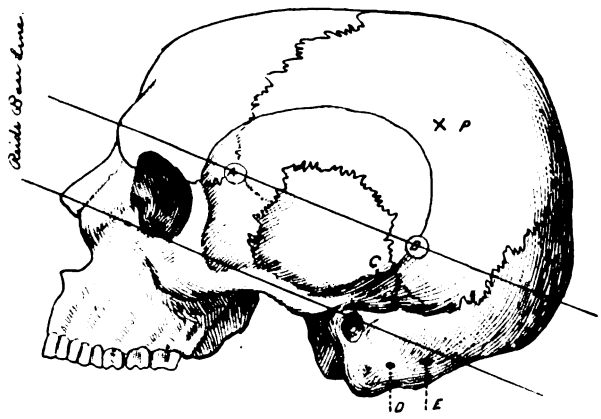
[2] Annals of Surgery, vol. vii., p. 401.

[3] Ueber die Indicationen zur Trepanation mit besonderer Berücksichtigung, etc., Deutsche Zeitschrift f. Chirurg., Bd. xxi. und xxii., 1885.

moreover, both middle meningeal arteries have been found ruptured in one reported case, and under such circumstances the skull would of course require to be opened on both sides.

As it cannot be ascertained before opening the skull whether the trunk, or the anterior or posterior branch, of the artery has been ruptured, a sufficiently large semilunar flap should be raised to give access to the whole middle meningeal distribution. The crown of a large trephine, one and one-quarter inches (3–4 centimetres) in diameter, is applied behind the external angular process of the frontal bone, on a line parallel to Reid's base line, and on a level with the uppermost portion of the orbital margin. (Fig. 1673, *A*.) If the clot is found here it must be gently removed by the finger or a Volkmann's spoon, aided by a stream of warm sterilized water.[1] If bleeding continues, the vessel can usually be secured by one of the methods suggested in my former article, enlarging the bone opening if necessary for this purpose by the rongeur; I have myself, however, been compelled to tie the external carotid artery to arrest otherwise uncontrollable hemorrhage, coming, as the post-mortem examination showed, from a wound of the main meningeal trunk as it passed through the foramen spinosum.[2] Should the anterior trephine opening show no clot, a second must be made in the same line just below the parietal boss (Fig. 1673, *B*), this showing that the bleeding vessel is often the posterior branch of the artery.[3] The anterior opening may now be closed with its own button, only the posterior being utilized for drainage (which should be by tube or iodoform gauze); or through drainage may be instituted. If only one bone opening has been requisite to remove the clot and secure the vessel, and if in the recumbent posture good drainage cannot be insured, the opening must be enlarged, or a second, more favorably located perforation must be made. Where a general excessive oozing persists from the small vessels, antiseptic tamponnade may be requisite, as in one case in my own practice and in more than one reported by other surgeons.

Fig. 1673.



A, Anterior point for application of trephine for middle meningeal hemorrhage. *B*, Posterior point for same. *C*, Point of perforation for cerebral abscess secondary to ear disease. *D*, Foramen for mastoid vein. *E*, Point of perforation for cerebellar abscess. *P*, Parietal eminence.

[1] Weak bichloride solution may be employed if preferred.

[2] Stroke (Berliner klin. Wochenschrift, 1892, No. 34, S. 860) reports his inability to secure this vessel by a ligature; he was compelled to leave a pair of hæmostatic forceps applied for two days, when they were removed without further bleeding taking place. See also Symonds, Trans. Clin. Soc., London, 1886, vol. xix., pp. 12–26 and 159–163.

[3] Although other rules have been given, I have found this reliable upon both the cadaver and the living subject.

SUBDURAL HEMORRHAGE—It has been suggested that as the middle cerebral artery can be easily reached by prolonging upward and backward the anterior bone-opening just mentioned, by means of the rongeur, the dura might be opened, the clot removed, and the main trunk sought for and tied in the Sylvian fissure if found to be the source of hemorrhage; but as subdural bleeding usually comes from numerous small meningeal or cortical vessels beneath the point of fracture, it is rarely possible to find the bleeding points, though, of course, if a clot were found it might be turned out and drainage instituted.[1] It must not be overlooked that hemorrhage by contre-coup[2] sometimes exists at a point opposite to the seat of external injury, and, if the symptoms indicate, must also be sought at that point.[3]

DIAGNOSIS OF HEAD INJURIES FROM ALCOHOLIC COMA AND APOPLEXY.

Phelps[4] has insisted upon the fact that, after recovery from shock, "an early, continuous, and very constant symptom in all classes of head injury," with encephalic lesions, is a rise of temperature; and that this "is a constant phenomenon, whatever the nature of the lesion or wherever situated," being probably "due to an affection of the cortex as a whole." In a very few exceptional cases the temperature may at first be depressed, but then it usually rises promptly to from 101° to even 109° F., usually not higher than 104.8°, notably in cases which are recoverable. In alcoholic coma, as pointed out in my former article, the temperature is depressed, ranging from 96° to 98° F., with slow or normal pulse, the depression of temperature being proportionate to the depth of the coma. In apoplexy, Phelps, in common with Bourneville, has found that at the outset the temperature is subnormal, and then nearly normal, remaining so if recovery ensues, but rising markedly if the case is to terminate fatally.

FUNGUS CEREBRI.

Ten years' further experience only more firmly convinces me that the comparatively low mortality I assigned to this condition, if properly treated, was warranted by facts. If a septic encephalitis be not the cause, or if the patient survive this disease, nature is fully competent to deal with the protrusion; absolutely nothing beyond aseptic, unirritating dressings, with support—not pressure—is requisite, the shrinkage of the enveloping layer of granulation-tissue effecting the reduction of the fungus.

[1] I have done thus once, evacuating fully six ounces of bloody fluid and old clots nearly three weeks after the primary injury. The source of the hemorrhage was not detectable; bleeding recurred in moderate amount and death occurred with elevated temperature a few days after the operation.

[2] Brain laceration is nearly always thus caused.

[3] See page 563 for methods of arresting hemorrhage from the vessels of the pia and brain substance.

[4] Phelps, Clinico-Pathological Study of Injuries of the Head with Special Reference to Lesions of the Brain Substance, New York Med. Journal, Jan. 14, 21, and 28, 1893.

Wounds of the Membranes.

Wounds of the dura mater when possible must be sutured with fine catgut; any deficiency may be repaired by a piece of pericranium, or possibly the future evils of adhesion between the scalp and brain may be obviated by placing over the brain an aseptic piece of heavy dentist's gold foil, cut so as to extend a short distance beneath the margins of the bony defect.

Cerebral and Cerebellar Abscesses.

These are never primary, but are secondary to such conditions as purulent periostitis and osteitis of the cranial bones; injuries to these bones, to the soft parts covering them, or to the underlying intracranial contents; or suppurations in the course of the lesser circulation, as in abscess of the lung, fœtid bronchitis, chronic empyema, etc. Abscesses from chronic suppurative ear disease, the most common cause, will be found treated of elsewhere.

Operations upon the nose, such as those for the removal of polypi,[1] have also produced abscesses of the brain—in one case there having been a focus of suppuration in each frontal lobe—so that it is well to bear in mind the possibility of there being more than one pus collection.[2] Zeller reports a case in which a phlegmonous process in the orbit was the starting-point of a brain abscess.[3]

Symptoms.—As large abscesses, for instance one in the temporo-sphenoidal lobe, increase the general intracranial tension by augmenting that of the cerebro-spinal fluid, the symptoms, in the absence of a clear history as to the sequence of the phenomena, are often obscure, and even at times misleading; fortunately, however, the pressure is usually so transmitted through the semi-solid brain substance that the neighboring centres are those most and first involved. In a general way the symptoms are those of pus formation, of general disturbance of cerebral function, and, in special cases, focal symptoms, as for instance, sensory, acoustic, or motor aphasia. Optic neuritis is often present, and occasionally reverses the rule, being more marked upon the side opposite the abscess. Tenderness upon pressure or to percussion over a limited area, with local elevation of temperature, is frequently noted. The chill which so commonly precedes an abscess in other localities is quite common, but the subsequent elevation of temperature, if it occur at all, is soon replaced by a normal or a subnormal temperature,[4] possibly rising near the termination of the process, often with delirium and with a second subsidence of the thermometer. The other symptoms, such as headache, vomiting, etc., are not peculiar to abscess, and have been noticed in my former article. No special focal symp-

[1] Parke, Medical News, Dec. 3, 1890, p. 617.
[2] Ransohoff, Journal of the Med. College of Ohio, 1892.
[3] Crawford Renton, Annals of Surgery, vol. iv., p. 334.
[4] See a case of Murdock's (Annals of Surgery, vol. ii., p. 81) where the fact that the pus was subdural, that is, a circumscribed collection due to adhesions probably arising from meningitis, gave a high temperature throughout, contrasting forcibly with the condition where the brain tissue is alone involved.

toms need mention, as they are variously grouped, and as no two cases are alike; unfortunately when the abscess occupies the frontal lobes, no localizing symptoms will appear until, perhaps, late, from secondary pressure, when they are more apt to be misleading than of service in arriving at a diagnosis. For the differential diagnosis the reader is referred to the remarks on meningitis, mastoid disease, extradural abscess, thrombosis of the lateral sinus, and pyæmia. I would urge that while the rule given as to the most probable time for the appearance of symptoms of cerebral abscess holds good in most instances, yet such cases as Weir's [1] show how late in the case pus formation may occur.

Operation.—Special care should be exercised in the administration of the anæsthetic, as respiration often becomes embarrassed or ceases just about the time that the abscess is reached. Where possible—as it often will be—no anæsthetic should be employed, ether being the one selected, if any be used. After elevating a proper flap at the point indicated by the scalp-wound, the osteomyelitic bone, or the seat of fracture, or when none of these exist—an unlikely contingency in the class of cases I am now considering—the bone, wherever the focal symptoms indicate, should be removed, a crucial incision should be made through the dura mater, and then pus should be sought for by passing a grooved director [2] in one or more directions toward the supposed locality of the abscess, after reaching which the track of the director must be enlarged by a small Volkmann's spoon, a drainage-tube—a metallic or glass one is preferable—introduced, and the cavity washed gently out with sterilized water or some weak germicidal solution.[3]

If the trephine opening is not favorably located for drainage, it will in some instances be proper to make a second bone perforation opposite the most dependent portion of the abscess cavity, passing thence a director into the abscess, and then proceeding as already suggested; the first bone opening can be closed by its own bone-disc, kept in warm aseptic water and nicked on one side to allow an exit for pus or wound fluids. To insure the patency of the drainage-tube, a small portion of the edge of the flap should be excised, or a piece cut out opposite the trephine opening. Great care in suturing and dressing should be taken to insure primary union of the flap, lest hernia cerebri occur. The tube must be very gradually shortened, and after its final withdrawal the case must be jealously watched for some weeks, lest a re-accumulation take place.[4]

Additional Methods for the Determination of the Fissures of Rolando and Sylvius.

As it is presupposed that the surgeon is familiar with the ordinary terms used in cerebral topography, no explanation of these will be given; he is also supposed to be acquainted with the location of the cerebral sinuses, etc., and only to require assistance in locating the fissures mentioned to be able to find any of the cortical centres.

[1] Annals of Surgery, vol. v., p. 505.

[2] The sharp aspirator needle is unsafe and, as I have found, becomes plugged with brain-tissue. Chiene uses a pair of small sinus forceps, and other surgeons boldly plunge in a bistoury.

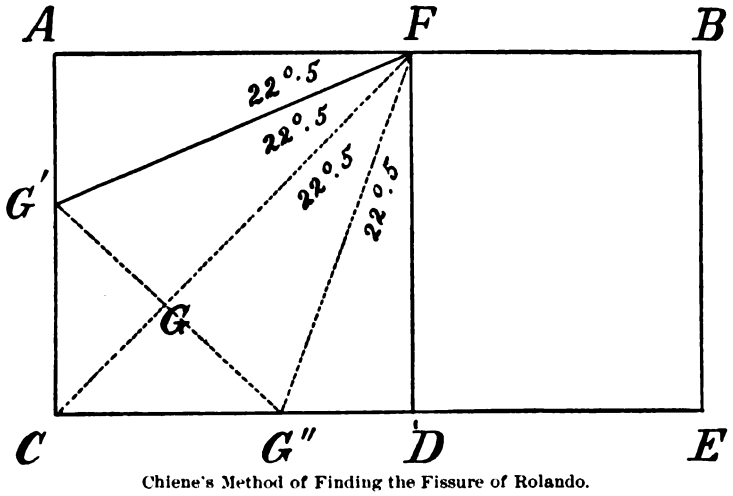
[3] Introducing a small amount of ethereal iodoform has been tried successfully.

[4] Fenger and Lee, Trans. Amer. Surg. Association, vol. iii., pp. 65 *et seq.*

Fissure of Rolando.—This starts half an inch behind the mid-point between the glabella and inion, usually running downward and forward at an angle of 67° for about 3¾ inches, the lower third of the fissure pursuing a more vertical course; but all skulls are not formed alike, so that the "cranial index" must be found, which is ascertained by dividing the transverse diameter of the head by the antero-posterior diameter; thus, if the "cranial index" be 75 the angle of the fissure will be 69°, while the angle will increase one degree for every two degrees of increase in the cranial index, and *vice versa*.[1] In children the fissure is situated more anteriorly, owing to the relatively smaller size of the anterior cerebral lobes, and in those under nine years the angle may be even as low as 52°.

A simple instrument constructed of two strips of parchment paper readily enables the surgeon to mark out this fissure. One strip—from 14 to 16 inches long—should be graduated in inches and fractions thereof, from the mid-point in both directions; to this is secured—one-half inch behind the middle point—the second strip at an angle of 67°; having ascertained the middle of the biaural line on the shaven scalp, the surgeon places the long strip in the median line thus ascertained, from the nasion to the inion, moving it until both scales read alike; for instance, the graduation should mark at the inion six and one-half inches, and the same at the nasion; the oblique strip is now 55.7 of the whole

Fig. 1674.



Chiene's Method of Finding the Fissure of Rolando.

distance between these points *behind* the nasion, and only requires to have its anterior margin marked on the scalp for 3¾ inches to indicate the fissure. More elaborate cyrtometers may of course be employed, but this suffices. Mr. John Chiene has recommended something even simpler; thus, ascertaining with a piece of string the midpoint between the inion and nasion, folding a piece of note-paper diagonally as indicated in the diagram, bringing the point *A* to *D*; now folding back *A* so that the line *A F* corresponds to *G F* and removing the triangle *G G'' F*; unfolding the paper, the line *F G'* will make with the line *F D* an

[1] For all ordinary purposes 67° may be considered correct.

angle of 67.5°, since each of the folded segments equals 22.5°; now placing *F D* along the antero-posterior line in the middle of the head, one-half inch behind the mid-point, the line *F G'* need only be traced on the scalp to indicate with sufficient accuracy the fissure of Rolando. (Fig. 1674.)

Fissure of Sylvius.—As the lower limit of the fissure of Rolando lies about one-half inch above the Sylvian fissure, it is often important for this, as well as for other purposes, to locate the latter. By causing the patient to alternately contract and relax the temporal muscle while tracing the temporal ridge with the finger, the point where the secondary ridge for the attachment of the temporal fascia crosses the coronal suture, that is the superior stephanion, can be determined, whence a line must be drawn which shall be perpendicular to the middle of the zygoma; a line drawn from the mid-point of this perpendicular line, passing upward and backward (nearly straight for its anterior half, more curved posteriorly) to within about half an inch of the centre of the parietal protuberance, will correspond to the course of the fissure of Sylvius. There are other methods of determining this,[1] but the one mentioned is that which I have myself always employed. The lower limit may be determined by drawing one line from the stephanion to the asterion, and a second passing through the bregma and the external auditory meatus, their point of intersection being about 1 cm. above the Sylvian fissure and over the lower extremity of the Rolandic fissure.

Trephining in Epilepsy.

Since this subject will be treated of in another article, the only addition to what I have already said in Vol. V. concerning epilepsy resulting from old compound fractures, scars of the brain or membranes, exostoses, etc., is that all scar-tissue in the brain and membranes should be freely excised as well as the depressed or thickened bone. The possible presence of displaced vessels or of much enlarged veins in these brain scars must be borne in mind.

[1] Reid's method is draw "a line from a point 1¼ inch behind the external angular process of the frontal bone to a point ¾ inch below the parietal eminence; the ascending branch of the fissure starts from a point ¾ inch back from the anterior end of this line and 5 cm. back of the external angular process." (Dana, Med. Record, Jan. 12, 1889.)

SURGICAL DISEASES OF THE HEAD.

BY

W. W. KEEN, M.D., LL.D.,

PROFESSOR OF THE PRINCIPLES OF SURGERY AND OF CLINICAL SURGERY IN THE JEFFERSON MEDICAL COLLEGE; SURGEON TO THE JEFFERSON MEDICAL COLLEGE HOSPITAL AND TO THE ORTHOPÆDIC HOSPITAL AND INFIRMARY FOR NERVOUS DISEASES; CONSULTING SURGEON TO ST. AGNES'S HOSPITAL AND TO THE WOMAN'S HOSPITAL, PHILADELPHIA; MEMBRE CORRESPONDENT ÉTRANGER DE LA SOCIÉTÉ DE CHIRURGIE DE PARIS, ETC.

SINCE the earlier volumes of this Encyclopædia were published, immense progress has been made in the surgery of both the central and the peripheral nervous system. In this article I shall consider only the surgery of the brain, exclusive of traumatisms.

As long ago as 1871, Broca located a cerebral abscess in the speech centre; but modern brain surgery really begins with the modest report of a case by Macewen in 1879,[1] and with a subsequent paper by the same author in 1881.[2] These publications unfortunately, however, attracted but little attention, and surgeons were blind to the opportunities for a great advance until Dr. Hughes Bennett and Mr. Godlee[3] narrated a case of sub-cortical tumor of the brain diagnosticated by localizing symptoms alone, and successfully removed. In October, 1886, and April, 1887, Mr. Victor Horsley published[4] two most important papers, which had a most important influence both in establishing the proper technique of operations upon the brain, and in diffusing a knowledge of its possibilities. In America, Roberts, Amidon, Seguin and Weir, Starr, McBurney, and myself, besides many others, have published numerous articles, which will be utilized in the following pages. In Germany the most elaborate and important paper is von Bergmann's "Chirurgische Behandlung von Hirnkrankheiten."[5] In France Lucas Championnière, Chipault, and others have published a number of excellent papers.

One fact should be especially noticed: that all of this practical progress would have been impossible had it not been for the quiet but persistent scientific work in laboratories, especially in Germany and England, by Fritsch and Hitzig, Ferrier and Horsley, and many other co-workers. No better argument could be adduced to prove the actual practical value of such scientific laboratory work, and no better inducement could be held out to American and other philanthropists for providing such means of research by ample endowments.

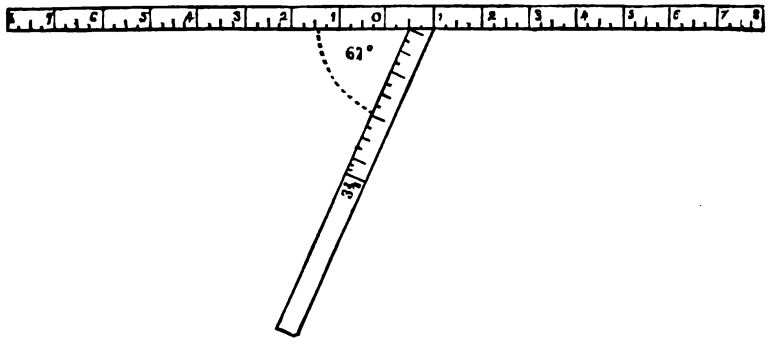
[1] Glasgow Medical Journal, 1879. [2] Lancet, 1881, vol. ii., p. 541.
[3] Ibid., Dec. 20, 1884. [4] British Med. Journal. [5] Archiv f. klin. Chir., Bd. xxxvi.

Technique of Cerebral Operations.

We owe the modern technique of cerebral operations principally to Mr. Horsley and Dr. Macewen. The entire head should always be shaved. The loss of part of the hair produces such a grotesque appearance that from an æsthetic point of view it is desirable; and for the surgical reason that we must take every means to avoid infection, it is still more desirable to shave the entire head. Moreover this often reveals unexpected scars. After the head has been shaved, the patient of course should be protected against taking cold by a silk handkerchief or a cap.

Marking the Cerebral Fissures.—The fissures of the brain should then be marked on the shaven scalp by means of an aniline pencil, espe-

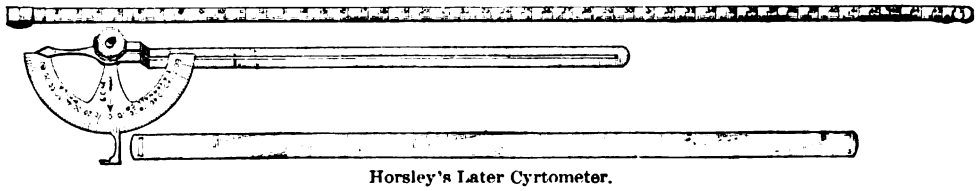
Fig. 1675.



Horsley's Cyrtometer as Modified by M. J. Lewis.

cially the median fissure, the fissure of Rolando, and in some cases the fissure of Sylvius, the fissure of Bichat, and others. The median fissure is easily marked, as it is about an eighth of an inch to the right of the median line, the left cerebral lobe being a little larger than the right. For marking the fissure of Rolando I have used with the best advantage Horsley's earliest cyrtometer (Fig. 1675), as modified by Dr. Morris J. Lewis. This consists of an antero-posterior arm 14 inches long and a lateral arm about 6 inches long. The lateral arm is fixed upon the antero-posterior arm at a point half an inch back of its middle,

Fig. 1676.



Horsley's Later Cyrtometer.

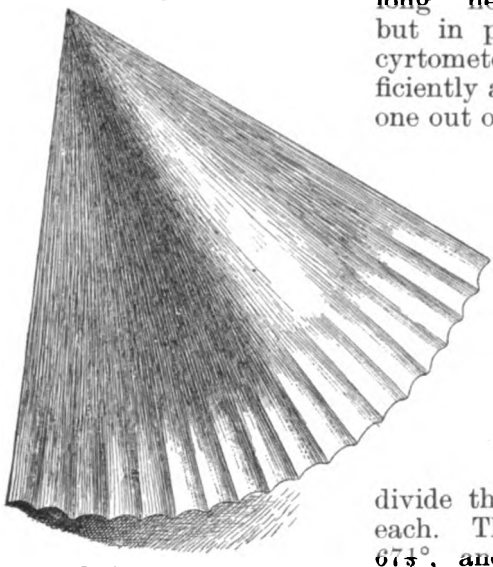
at an angle of 67°. The zero point of the scale on the antero-posterior arm is at the middle and is graduated in inches forward and backward. The lateral arm should be graduated for a distance of $3\frac{1}{4}$ inches, which

will mark the end of the fissure of Rolando. In using it, the antero-posterior arm is placed one-eighth of an inch to the right of the median line, and in such a position that the inion and the glabella will each correspond to the same figures on the scale. For instance, if the distance from the glabella to the inion is 13 inches, the reading on the scale, front and back, will be 6½ inches each. The zero point will correspond to the middle of the distance between the two points named, and the lateral arm will start half an inch back of this mid-point. Mr. Horsley has devised another cyrtometer (Figs. 1676, 1677), much more elaborate, and so arranged that the angle of the lateral arm can be changed to correspond to very broad or very long heads; but in practice I have found the simple cyrtometer the more easily used, and sufficiently accurate. It can be made by any one out of an ordinary piece of stout paper if one of metal is not at hand.

Fig. 1677.

Horsley's Later Cyrtometer Applied.

Fig. 1678.

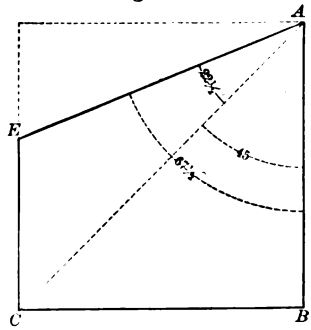


Buchanan's Cyrtometer.

Buchanan, of Pittsburgh,[1] has devised a simple modification of this, consisting of a triangular piece of aluminium, the radius of which is 3¼ inches and the angle 67°. (Fig. 1678.)

Another method has been devised by Chiene, of Edinburgh, by taking a square of paper and folding it diagonally from the same corner twice, which will divide the apex into four angles of 22½° each. Three of these angles will give us 67½°, and when applied to the head will mark the fissure of Rolando with very fair accuracy. (Fig. 1679.)

Fig. 1679.



Chiene's Method of Fixing the Fissure of Rolando.

The fissure of Sylvius begins 1⅛ inches posterior to the external angular process, on a line drawn from this process by the shortest route to the inion. From this it proceeds in a straight line toward and a little below the parietal eminence.

The fissure of Bichat runs in a line from the external auditory meatus to the inion. For the location of the other fissures of the

[1] Amer. Jour. Med. Sci., July, 1893, p. 20.

brain the reader is referred to the edition of Gray's Anatomy, edited by myself.[1]

The day before the operation the head should be shaved anew, if necessary, scrubbed with soap and water, then with ether, then with a sublimate solution 1–2000 only, as stronger solutions are apt to vesicate. A sublimate dressing, the three or four inner layers which are wet with the solution, should then be applied and left in place until the operation, when the disinfection should be repeated. Of course all the ordinary precautions as to thorough cleansing of the finger-nails, hands, and arms of the operator and his assistants, and of the instruments and dressings, should be scrupulously carried out.

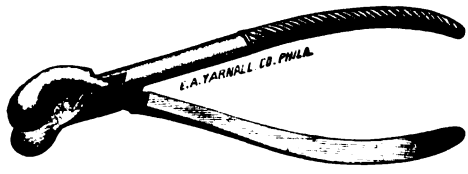
The best position for the patient is the semi-recumbent, in order to diminish hemorrhage. Three points should be marked on the bone: viz., the two ends of the fissure of Rolando and the point at which the centre-pin is to be placed, if the trephine is to be used, the reason for this being that, once that the scalp is raised, the position of the fissure of Rolando and the exact point for trephining are not easily re-determined. The marking of the bone may be done with a small gouge, or with the centre-pin of another trephine, the rongeur forceps or other instrument serving as a hammer.

ACCESS TO THE BRAIN.—In very many cases the ordinary operation of trephining will suffice to give access to the brain. As the first step in linear craniotomy, tapping the lateral ventricles, elevating fragments, and numerous other operations on the brain, this will be always the most feasible and favorite method of operating. Where we desire simply to get under the bone, as in linear craniotomy and in most cases of fracture, at least the recent ones, a small trephine (half an inch or an inch) will answer the purpose. When, however, access to any considerable portion of the brain is desired, either an inch-and-a-half trephine should be used, or multiple adjacent openings should be made by an inch trephine, the intervening bridges of bone being chiselled or sawn away, or bitten away by the rongeur forceps. If the opening is too small it can readily be enlarged in any direction by the same forceps, of which two forms are here shown. (Figs. 1680, 1681.)

Fig. 1680.

Luer's Double Rongeur Forceps.

Fig. 1681.



Hopkins' Rongeur Forceps Modified by Weir.

Another method, however, has recently obtained great favor, and very justly, from the much larger area of the cerebral surface which it exposes, both for determining the fissures and convolutions and for operative attack, and also from the better reëstablishment of the integrity of the skull. As long ago as 1863, Wolff[2] proposed and performed on animals a temporary or osteoplastic resection of the bone. He first ex-

[1] Op. cit., p. 681, Philadelphia, 1887.

[2] Arch. f. klin. Chir., Bd. iv.

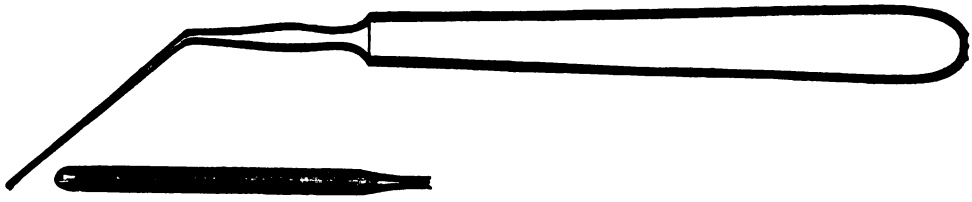
posed the bone covered by the periosteum. Three sides of bone were then chiselled through, the periosteum being divided. The fourth side was chiselled carefully under the periosteum, and the bone was then turned back on the latter as a hinge. To Wagner, however,[1] is due the credit of a greatly improved method of temporary osteoplastic resection suggested by Wolff's experiments. At the desired point an omega-shaped (Ω) incision is made through the soft parts, directly down to the bone, to which the scalp is carefully left attached. The external table of the skull is then chiselled through, either by ordinary chisels, or, better, by the chisels employed by wood or ivory carvers, which can be had at any good hardware store, or by the special chisels devised by Hartley or Pyle. These, however, I find too long. They should not be over five and a half inches in length, which makes them much more manageable. The diploe having been reached, care should be exercised, in going through the vitreous table, not to wound the dura mater. To this end an osteotome and not a chisel should be used to cut through the inner table. The blows of the mallet, as has been said by Mr. Chiene, should not be rude, forcible blows like those of a carpenter, but rather like those of the sculptor. One or more elevators then being inserted under the edges of the bony flap, the portion of the bone between the two ends of the omega is fractured, and the united flap of bone and scalp is turned downward, the scalp serving as a hinge. Macewen drills or saws the bone along the line of fracture, under the soft parts. This method of operation, however, will be difficult of execution in case the skull is very thick. Fowler's case[2] showed this to be a serious difficulty. Hence I would advise, in all adults, that first of all a small trephine-button (say half an inch) should be removed at the summit of the incision, in order to determine what the thickness of the skull is, and whether an osteoplastic resection is feasible. If the skull is over a quarter of an inch thick I would much prefer multiple adjacent trephine-openings, with removal of the intervening bony tissue. Otherwise the Wagner-Wolff method is undoubtedly by far the best method of opening the skull. A bony flap as large as 11 by 9 centimetres has been made by Wagner. When the operation is completed, the bone is simply turned back on its hinge, a bit of it is gnawed away by the rongeur forceps if drainage is to be employed, and the bone is held in place by the ordinary sutures through the scalp alone. Care should be taken not to cut away the margins of the vitreous table, which will project from the under surface of the margins of the opening in the skull, in order that when the flap of bone is replaced it may lie upon them as supports, and not press upon the brain. Before turning the flap back into position the edges of the fractured portion should be freed from any splinters. Dr. Griffin, of Lincoln, Nebraska, has thus avoided serious disaster from the penetration of the dura by such a splinter.

When the cranial cavity is opened, the dura may be separated from the bone by Horsley's dural separator (Fig. 1682). This will enable the surgeon to examine the inner surface of the skull and to detect irregularities. With care, the little finger may readily be inserted between the dura and the bone—and afterward if need be, between the dura and the brain—and the bone and brain may be examined over a

[1] Centralbl. f. Chir., 1889, No. 47. [2] Med. Record, June 16, 1894.

large area. As a rule the dura should be opened. The added danger is slight and the additional information may be very great. The opening in the dura should correspond to that in the skull, its margin being about a quarter of an inch from the margin of the opening in the bone. Care should be taken not to wound the large veins immediately beneath the dura, for the sudden loss of a large quantity of blood from the brain induces severe shock and may even produce speedy death. These veins may best be avoided by lifting the dura by rat-tooth forceps while making the first incision with the knife, and then using blunt-pointed scissors. If we have to deal with a tumor which has produced great intracranial pressure, it is often best to make one or more very small incisions in the dura first, and then to enlarge them or not, according to circumstances. Hemorrhage from branches of the middle meningeal artery is best arrested either by hæmostatic forceps, by direct ligature at the point of section, or, usually to greater advantage, by passing a ligature through the dura and under the vessels by means of the finest Hagedorn semicircular needle. One of the most troublesome problems in cerebral surgery is hemorrhage from the large vessels in the brain itself. Some of the larger arteries may be directly tied, and this is the best way of arresting the bleeding. The veins, however, are

Fig. 1682.



Horsley's Dural Separator.

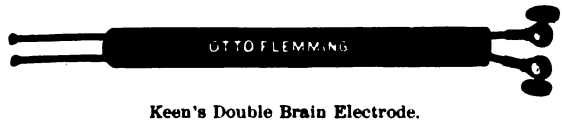
extremely fragile and difficult to secure. Not uncommonly it may be necessary, for either arterial or venous hemorrhage, to pass a small semicircular Hagedorn needle partly through the brain substance and around the bleeding point. The ligature, which should be of non-chromicized catgut, should be tied with great gentleness, care being taken to see that the traction is equal on both ends of the ligature, so as not to tear the fragile vessel. The knot should not be tied too tightly, lest it cut through. Very often hemorrhage from the brain may best be arrested by pressure, either by gauze or sponges, with or without hot water, at from 105° F. to possibly 115°. In hemorrhage from the sinuses, if the lips of the wound can be seized by hæmostatic forceps, this will quickly arrest the bleeding The forceps may be left in place for from 36 to 48 hours, being entirely enclosed in the dressing to prevent infection. Pressure upon the sinuses, however, or plugging them with iodoform gauze, will usually control the hemorrhage. As the large cerebral veins approach the superior longitudinal sinus, they suddenly broaden into large bays, called the para-sinoidal spaces. These should always be avoided if possible, and if wounded they must be either plugged with iodoform gauze or secured by hæmostatic forceps, or occasionally by ligature.

After opening the dura, we should first observe whether the brain bulges, and also the amount of the bulging, which is an index to the

degree of pathological increase in the intracranial pressure, due to tumor, abscess, internal hydrocephalus, etc. Next the color should be observed. Lividity, or a yellowish tinge, will probably indicate a tumor. Old lacerations show a dirty yellowish-brown. Œdema of the membranes is not uncommon, sometimes to such an extent as to obscure to a great measure the sulci and the convolutions. I once saw it on one side of the brain, of a dense reddish color, caused by bloody serum for which no evident cause was discovered. On nicking the membranes, the serum will escape, and the sulci and convolutions may then be recognized. Absence of pulsation usually indicates a large tumor, abscess, or cyst. The consistence of the brain should always be determined by touch, and the exactness of one's appreciation of its density by touch grows, of course, with experience.

The brain being exposed, we can ascertain the location of any motor centres by faradization. If this is to be done, no antiseptics should be employed after the dura has been laid bare, as they all dull the reaction of the cortex to electricity. Only sponges, or sterilized gauze wrung out of hot water, should be used. Sachs has demonstrated that this faradization and recognition of the motor centres can also be done through the unopened dura. An ordinary faradic battery suffices. The current should be just sufficient to stimulate the thenar muscles. A double brain electrode which I devised some years ago I have found very useful (Fig. 1683). The points should be sterilized by carbolic acid and the handle wrapped in antiseptic gauze. When the brain is faradized, the face and the four extremities should be uncovered, and one observer asked to note the phenomena in each of these five regions. At the same time the points stimulated by the battery should be determined by exact measurements, taken laterally from the middle line and antero-posteriorly from the fissure of Rolando. A stenographer should be present to record from dictation the observed phenomena rapidly and exactly. Should any centre or centres, or any abnormal portion of the brain, be removed, it should be done thoroughly, and in doing this it must be remembered that it is safe to cut much more freely antero-posteriorly than vertically, since in the latter direction adjacent centres are more quickly encroached upon than by an antero-posterior excision.

Fig. 1683.



Keen's Double Brain Electrode.

In ordinary cerebral operations it is best not to drain, but to close the wound completely, leaving if need be a little gap between two of the sutures both anteriorly and posteriorly for the escape of wound fluids. If these accumulate at the end of 24 hours, and sometimes at a later period, a pair of hæmostatic forceps or a probe may be inserted between two stitches, and the redundant fluid pressed out. In operations for cysts, drainage is not uncommonly required, and in those for abscesses, gunshot wounds, hemorrhage, etc., it is a necessity. As a rule, rubber tubing is the best. Folded rubber dam is often useful.

When the operation is completed, the dura should be sutured by interrupted or continuous catgut stitches. The point of the needle should be introduced *toward* the bone, so as to allow plenty of room for the

movements of the needle-holder and the eye of the needle in the opening in the skull.

CLOSURE OF THE OPENING IN THE SKULL.—If the osteoplastic method of temporary resection of the skull has been used, the method of closing the opening has already been indicated (p. 579). If a trephine button has been removed, however, the technique is different. Following the indications of Ollier, Dr. Macewen in his first paper advised that the opening in the skull should be closed by replacing the bone. If the button of bone is to be replaced in one large piece instead of in small fragments it must be most minutely cared for. The surgeon may place it, as I commonly do, in a teacup containing 1–2000 bichloride solution, the teacup being placed in a basin which is partly filled with hot water from time to time, and by a thermometer kept at a temperature of from 100° to 105° F. It may also be kept, of course, in a carbolic acid solution, 1–40, or even in warm, previously boiled water. Macewen cut it up into small fragments and laid them on the dura, but this has been found an unnecessary labor and prolongation of the operation. I have replaced the entire trephine button, an inch and a half in diameter, more than a dozen times, and where it has had suitable care have never once seen it produce the slightest trouble even in adults. In one case where the dura had been removed, I perforated the button at the centre-pin fossa and passed a chromicized catgut stitch through this and around the periphery, and thus sewed it to the under surface of the flap of scalp, with a perfect result.

Whether it will be best in many cases to replace the bone is as yet an undecided question. If the bone is diseased it should not be replaced. In those cases also in which we wish to bring about any change in the intracranial pressure, as for instance in cases of headache and of irremovable tumors, where we operate to relieve the pressure, the bone should not be replaced. In several cases in which I have done secondary operations, after a previous trephining or after fracture with loss of considerable bony tissue, I have found the opening closed by a firm fibrous membrane, which would give excellent protection to the brain excepting from sharp, penetrating objects. To protect the brain from such possible accidents I usually cover an oval piece of tin, somewhat larger than the opening in the skull, with silk, and sew it inside a skull cap.

In many cases, most commonly from old fracture with large loss of bone substance, it is desirable to close the deficiency by a secondary operation. For this purpose the procedure of Koenig[1] is by far the best. In this case a gap, 8 by 5 centimetres, existed in the temporo-frontal region. The scar and fibrous tissue were removed. Then a flap of adjacent scalp of similar shape, but a little larger than the opening (to allow for shrinkage) was cut through on three sides down to the bone, but not separated from it. The fourth formed its pedicle. By a rather narrow, small chisel, the outer table of the skull under the flap so outlined was chiselled loose, becoming of course fractured into small pieces which remained adherent to the under surface of the flap. This flap of scalp and bone fragments was now shifted so as to fill the bony defect, and was sutured into place, the raw surface of diploe from which the flap

[1] Centralbl. f. Chir., 1890, No. 27.

had been chiselled being then covered by Thiersch's method of skin-grafting. In a case reported by Czerny [1] the subsequent changes in such a bony flap are shown. After closing the bony defect by this method, he was subsequently obliged to do a second operation. On reflecting the flap of bone with which he had filled the opening, he was gratified to find that there had developed on its inner surface a smooth, bony plate, practically a reproduction of the vitreous table. Titze [2] put this method to its severest test. In a case in which he was obliged to remove the dura mater, when his osteo-cutaneous flap was slid into place, the rough inner surface of the bone came in direct contact with the pia mater. The wound healed, however, by primary intention, and without the slightest difficulty from the rough surface of the bone. The explanation of this is probably to be found in Czerny's observation just quoted. The most extensive operation of this kind that I have seen reported is by Schönborn.[3] In this case there was a large transverse defect on the upper forehead. The scar was extirpated, opening the sub-arachnoid space. A flap of scalp and bone, 6 or 7 centimetres broad and 25 or 26 centimetres long, was formed just posterior to the defect, through the hairy portion of the scalp, by two transverse incisions, the two ends of the flap being its pedicles. This flap was then shifted forward, the outer table of bone having been chiselled away with it and transplanted with the flap to its new position. The raw surface left behind the defect was then filled by Thiersch's method of skin-grafting. As by this operation a large part of the forehead was covered by hair, it caused the patient much annoyance. Four months afterward, the scar of the first operation, behind the original bony defect—that is, the skin-grafts—was dissected out, and the flap of scalp which had been displaced to the forehead was dissected loose from the underlying bone, which was not disturbed, and was then shifted back to its original position. The bony defect, being found well closed, was then covered in its turn by Thiersch's method.

Besides such filling of defects in the skull by replacing the original trephine button, or by Koenig's method, other plans have been devised for closing the opening. Thus Ricard [4] filled a defect of 5 by 4 centimetres, in the frontal bone, by using the hip-bone of a dog and a bit of the femoral condyle. The bone was bared of all its soft parts, including the periosteum. Three months later no loss of substance was perceived. I attempted the same procedure in one case by taking a portion of the skull of a lamb, but the attempt was a failure, largely I think from the fact that I did not provide for drainage, and hence the wound fluids accumulated between the soft parts and the transplanted bit of bone, which underwent a harmless necrosis and ultimately was removed. In another instance I filled the defect by decalcified ox-bone, but without a favorable result, the decalcified bone becoming absorbed and not replaced by bony tissue. It is probable that in all similar cases the decalcified bone simply forms a scaffolding, on which in many cases fibrous, and occasionally bony, tissue is built. Fraenkel [5] proposed to insert a plate of polished celluloid, and after trying it successfully in

[1] Verhand. Deutsch. Gesellsch. f. Chir., 1892.
[2] Arch. f. klin. Chir., Bd. xlv., 1893, S. 227.
[3] Beil. Centralbl. f. Chir., 1891, S. 88, and Verhand. Deutsch. Gesellsch. f. Chir., 1891, S. 225.
[4] Gaz. des Hôp., 23 Juillet, 1891, p. 785. [5] Centralbl. f. Chir., 1890, S. 821.

dogs, recommended its use in man. Hinterstoisser[1] inserted such a plate on the fourth day after the operation, stitching the periosteum over it, and obtained primary union, with disappearance of the brain symptoms. In discussing this case, Fillenbaum referred to two other successful cases, and von Eiselsberg[2] has also reported two cases. One of them was entirely successful after 8 months. In the second case, on the fourth day a clot was discovered under the plate; the latter was removed, and after two weeks was reinserted, with a favorable result two months subsequently. Seydl[3] filled a gap of 5 by 4 centimetres by inserting six or eight pieces of bone and periosteum from the patient's tibia.

The scalp, or the osteoplastic flap of bone and scalp, separated by Koenig's method, having been replaced and secured by ordinary interrupted sutures, best of silkworm gut, an ample sublimate or sterilized dressing should be applied, as there is apt to be considerable oozing after the operation. The dressing is covered with rubber dam and retained in place by a wet gauze bandage, then by an ordinary muslin bandage, and, in the case of children, by a night-cap. As soon as the dressing is moistened to its margin by serous or bloody discharge, the wound should be redressed, and attention should be given to the evacuation of any retained fluids. If a drainage-tube has been used it should be removed at the end of 24 or 48 hours, except in cases of abscess or allied conditions, when it must remain for some days. Usually by the fifth or sixth day half the stitches may be removed, and the remainder by the seventh or eighth day. Absolute quietude both of body and mind should be insisted on, especially for the first week. No letters, visitors, or other causes of excitement should be allowed for some time. Although less severe restrictions may sometimes be required, yet as a rule this regimen should be enforced for at least two weeks, and occasionally to some extent for months, after such an operation.

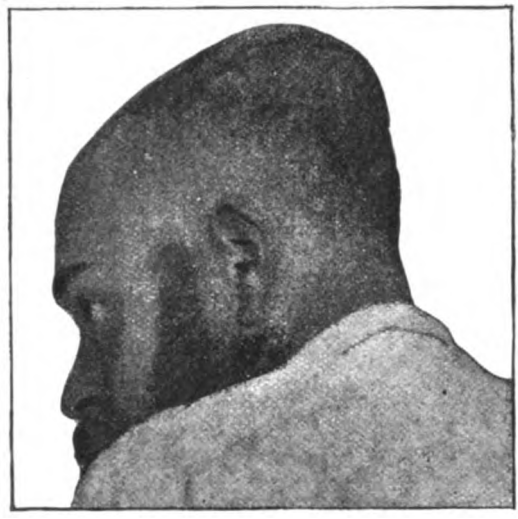
SECONDARY OPERATIONS.—In these, which are not uncommonly required, the brain, its membranes, and the bone will all be adherent, and must be dissected apart with great care. Some of the brain tissue will of course be torn away, and occasionally more or less decided paresis of the corresponding centres may be produced. After primary removal of a motor centre there is of course entire paralysis of the part supplied by it, and the pressure caused by the blood-clot which accumulates after an operation, and by the later cell proliferation, is apt to cause widespread paralysis, sometimes amounting even to hemiplegia. As a rule, after some weeks this disappears to a greater or less extent, leaving the affected muscles, however, somewhat paretic. The same effect may follow a secondary operation, but the paresis or paralysis is apt, I think, to be less pronounced, unless the cerebral traumatism has been extensive.

If at either a primary or secondary operation any of the dura has been removed, and especially if there has been also removal of any brain substance, there will be a very marked tendency to proliferation of the cerebral tissue, with risk of the formation of a fungus cerebri. Some years ago[4] I suggested that this might be prevented, and the loss

[1] Wien. med. Presse, Bd. xxxi., 1890, S. 1670. [2] Centralbl. f. Chir., 1891, S. 926.
[3] Ibid., 1889, No. 12. [4] Amer. Jour. of the Medical Sciences, Sept., 1891, p. 227.

of substance in the dura made good, by taking a portion of the pericranium from the under surface of the flap in the scalp, turning its osteogenetic surface upward, and sewing it to the dura by interrupted sutures. I have had to do this in two cases, which were perfectly successful. Sometimes when the bone is not replaced there will be great bulging of the flap, due it may be, in some instances, to what might be called a subcutaneous fungus cerebri, together with accumulation of the cerebro-spinal fluid. Fig. 1684, taken from one of my patients, shows this to a very marked degree. In a later, similar case, a secondary operation for the removal of a piece of necrosed bone gave me an opportunity to see under the scalp, and thus to verify the fact that the major part of the protrusion was due to such a fungus cerebri, the remaining swelling being due to cerebro-spinal fluid. This emphasizes the need for immediate and entire closure of the scalp wound in cases in which the brain substance has been lacerated either by the original injury or during an operation, in order to prevent an open fungus cerebri with all its dangers.

Fig. 1684.



Bulging of Scalp After Removal of Dura and Brain Substance.

The *limits of our operative procedures* are constantly being widened. As has already been mentioned, by the dural separator, the probe, and the finger, a large part of the inner surface of the skull may be explored. The brain may be depressed by the finger, or by a knife-handle or spoon-handle, used with gentleness, and the surgeon can easily see an inch or more beyond the opening. Toward the base of the skull the brain may be lifted, with or without the dura, and the floor of the skull be explored almost to its centre, so that from the front we can discover the anterior clinoid process, laterally the entire anterior and posterior surface of the petrous bone, and posteriorly the bone under the cerebellum, while from the exterior also both the finger and the eye can reach the foramen magnum. In several instances I have separated the dura from the skull over the sinuses, so that they could be explored and their condition ascertained. The brain may be punctured almost with impunity with a blunt instrument, such as a grooved director, so as not to wound the large vessels; and the lateral ventricles may be tapped from almost any direction.

TRANSPLANTATION OF CEREBRAL TISSUE.—Salviati,[1] Prus,[2] and Thompson[3] have experimented on the transplantation of cerebral tissue

[1] Wien. med. Presse, 1889, S. 838.
[2] Annals of Surgery, vol. ix., 1889, p. 225.
[3] New York Medical Journal, Jan. 28, 1890.

from one animal to another with some degree of success. Whether this can ever be done from an animal to man, is doubtful, but further experiments in animals are desirable.

Abscess of the Brain.

Causes.—By far the most common cause of abscess of the brain is suppuration of the middle ear. This is the cause in perhaps 50 per cent. of intracranial abscesses, and will be considered in connection with other intracranial lesions of similar origin.

Next to disease of the ear, traumatism is the most frequent occasion of brain abscesses. They arise sometimes even from simple contusions from which recovery may apparently have taken place for weeks or even months or years. Thus Mr. Damer Harrisson [1] has reported a case arising ten years after the injury. Souques [2] also reports one arising eleven years after fracture. In a very remarkable case published by Macewen [3] a very large secondary cerebral abscess seemed to have had its origin in an old encysted abscess, the cause of which is not given. The acute abscess had destroyed practically the whole of the temporo-sphenoidal lobe, and involved the third frontal and ascending convolutions. After several ounces of pus had been evacuated, the old encysted abscess was seen floating like a tennis-ball in the cavity of the secondary abscess.

In addition to this, abscesses may arise from exposure to cold, and in at least three cases [4] the origin of the trouble seems to have been an attack of influenza. In Clutton's case there was also thrombosis of the lateral sinus and the internal jugular vein, as well as generalized pyæmia, yet the patient recovered. Schindler [5] has also recorded a case following inflammation of the frontal sinus, probably a result of grippe. Treves [6] has recorded a case following phosphorus necrosis of the upper jaw. Griffith [7] recites one caused by caries of the orbit. Walton [8] reports a very remarkable case, and the first reported, of successful diagnosis and evacuation of a cerebral abscess following fetid pneumonia. Virchow demonstrated the occurrence of these abscesses after gangrene of the lung, and Nathe [9] reports cases following pulmonary abscess, gangrene, infective pneumonia, pleurisy after wound of the lung, endocarditis, empyema, and bronchiectasis. Occasionally also tubercular abscesses are found in the brain.

Pathological Anatomy.—An intracranial abscess may exist between the dura and the skull, *extra-dural abscess*, which almost always arises from caries of the petrous portion of the temporal bone (*vide infra*); or, secondly, between the dura and the brain, *sub-dural abscess;* or, thirdly, in the substance of the brain, *cerebral* or *cerebellar abscess.*

[1] Brit. Med. Journal, Apr. 21, 1888.
[2] Gaz. Méd. de Paris, 1888.
[3] Brit. Med. Journal, 1888.
[4] Zeller, Berl. klin. Wochenschr., 1892, No. 34, S. 869; Clutton, Brit. Med. Journal, 1892, vol. i., p. 807; Williamson, Manchester Med. Chronicle, March, 1891.
[5] Centralbl. für Chirurgie, 1893, S. 24.
[6] Lancet, 1892, vol. ii., p. 1349.
[7] Manchester Med. Chron., May, 1889, p. 167.
[8] Boston Med. and Surg. Journal, Nov. 17, 1892, p. 473
[9] Deutsch. Arch. für klin. Med., Bd. xxxiv., S. 161.

Excepting extra-dural abscess, we have as yet no means of accurately distinguishing these forms during life. If the abscess has arisen from traumatism, it will generally lie under the site of the injury, in which case a scar will commonly be a guide to its location. It may, however, exist on the opposite side of the head, caused by laceration of the brain from contre-coup. Its position should be determined much more *by the localizing cerebral symptoms* than by the history, or by the scar, which may be at a distance, as for instance in Macewen's case,[1] in which though the cicatrix was on the forehead the abscess existed in Broca's lobe, and as in Harrisson's case already alluded to. The differential diagnosis between abscesses in the cerebrum and in the cerebellum will be considered under Abscess from Ear Disease.

The abscess may contain only a drachm or two of pus, or on the other hand may involve the greater portion of one hemisphere.

Intracranial abscesses are commonly single, but in cases of pyæmic or tubercular origin they are more apt to be multiple. If of large size they frequently burst into the lateral ventricles. Thus Koerner[2] records that there were 10 instances of rupture into a lateral ventricle in 100 cases of abscess, and in one, rupture into the fourth ventricle. These ruptures are invariably fatal.

SYMPTOMS.—The symptoms of intracranial abscess are threefold: 1, Those due to the suppurative process; 2, those due to pressure; and 3, the focal or localizing symptoms.

1. *Symptoms due to the Suppurative Process.*—The general rule that suppuration is attended with a rise of temperature has its most important exception, as shown by Hulke in 1886, in intracranial abscess, in which, unless the abscess be extra-dural, the temperature is commonly and often constantly either normal or subnormal, even when the patient is desperately ill. Sometimes there is a slight rise at the beginning, and again toward the end of the disease there may be a second rise, often accompanied by delirium, only to be followed by another fall and a still later rise if life is sufficiently prolonged; but if the patient is in grave peril, with the ordinary symptoms of intracranial lesion and with a subnormal temperature, abscess should be the first thought in the surgeon's mind. A chill not uncommonly occurs, but may be absent. The ordinary phenomena of illness, that is, anorexia, vomiting, general malaise, are present. According to Somerville, when there is pus in the brain the urinary chlorides will be below normal in quantity, and the phosphates above. If the abscess is large, possibly peptonuria may exist.

2. *Symptoms due to Pressure.*—Headache is usually exceedingly severe, so that the patient is constantly moaning. It may be located over the lesion, but is often either general, or misleading in its position. The pulse, as pointed out by Hulke, is always slow, and may fall even to 30 or 40. The respiration may be Cheyne-Stokes in character. The mind becomes dull, and the apathy may gradually deepen into coma, the bowels and bladder being then evacuated involuntarily. Convulsions of the epileptiform type sometimes occur, but not uncommonly are absent. Sensation is not generally impaired. Optic neuritis is not a reliable symptom, excepting perhaps in extra-dural abscess.

[1] Loc. cit., p. 303, case i. [2] Arch. f. Ohrenheilk., Bd. xxix., 1889, S. 15.

When present, it may exist on either one or both sides. It is apt to be most marked on the same side as the abscess, but this condition may be reversed. The pupil on the same side as the lesion is commonly dilated, and more or less immobile, but the rule is not absolute. Marked fluctuations in the general condition of the patient often occur.

3. *Focal or Localizing Symptoms.*—If the abscess exist in the left temporo-sphenoidal lobe, it may compress Broca's convolution and produce motor aphasia. Paralysis of the levator palpebræ (ptosis), or of the other muscles supplied by the third nerve or the sixth, may be present. In the Rolandic region abscess may produce paralysis of the opposite side of the face, or of the opposite arm or leg, according to its situation. Sometimes, if the pus begins low down and creeps upward, the centres will be involved in the order named. If the sixth nerve is involved there will be distinct squint.

If the abscess arises in the frontal lobe, from injury or from nasal disease, localizing symptoms are not apt to occur; and the same is true of abscess in the occipital lobe, unless the disease involves the cuneus, when blindness of the same half of each retina will occur (homonymous hemianopsia). If the angular or supra-marginal gyrus be affected, there may be monocular Argyll-Robertson pupil, as has been pointed out by Oliver.[1] It is doubtful whether the local temperature of the two sides of the head is a reliable guide. Sufficient observations have not been made to determine this point. The left side of the head, it must be remembered, is normally of a somewhat higher temperature than the right. Pressure and percussion may be of value to localize the abscess, but too much reliance must not be placed upon them. According to Ferrier, pain which is not spontaneously complained of, but which is elicited by percussion, is of greater value than tenderness on pressure.

DIFFERENTIAL DIAGNOSIS.—(1) *Meningitis.*—The diagnosis between abscess and meningitis is often very difficult. Meningitis following traumatism, however, is apt to develop within the first few days, but abscess does not commonly occur before the end of the first week. In meningitis also there is apt to be very early mental dulness, deepening into coma, or oftener, especially at the beginning, actual delirium, with photophobia, contraction of the pupils, high general temperature, and marked stiffness of the muscles at the back of the neck. The ordinary causes of cerebral abscess also are usually absent.

(2) *Mastoid disease* following suppurative disease of the middle ear will sometimes cause very serious cerebral disorder without producing an abscess. Trephining the mastoid, which should always be done at an early period, will eliminate this factor from the problem. Ordinarily also the symptoms of mastoid disease—œdema, swelling, pain tenderness, otorrhœa, particularly an otorrhœa of long standing—will be present. It must be remembered, however, that cerebral abscess is not uncommonly a sequence of mastoid disease.

(3) *Tumor* is ordinarily very slow in its development, and, at least in

[1] Amer. Journal Med. Sciences, Oct., 1888, pp. 349, 355. By the term "Argyll-Robertson pupil" is meant a pupil which is more or less contracted, but in which the iris, although it will vary with accommodation and convergence, will not contract in response to the stimulus of light thrown on the retina.

the motor region and a few others, has distinctly localizing symptoms at an early stage. Abscess, on the contrary, although it may begin long after an injury, when once it has started follows an acute course. Moreover the ordinary causes of abscess, such as aural disease, traumatism, pulmonary disorders, etc., will commonly not be present in cases of tumor. Optic neuritis, on the other hand, is almost always present in tumor, far more frequently than in abscess. Again, the common locations of abscess are either the temporo-sphenoidal lobe or the cerebellum, but tumors are comparatively rare in these two situations. In other parts of the brain, on the contrary, abscess is rare and tumor much more common. The temperature is not apt to rise in tumor, but in abscess is apt to show a prolonged subnormal fall. In syphilis, tumor is much more common than abscess.

TREATMENT OF INTRACRANIAL ABSCESS.—Dupuytren, Detmold, Morehouse, and others evacuated abscesses of the brain many years ago, but the modern surgery of these cases has arisen during the last ten years, since cerebral localization now enables us to diagnosticate, localize, and therefore reach such abscesses with comparative accuracy. As soon as the existence and location of an intracranial abscess have been determined, operation should be instantly resorted to, since if let alone all such cases end in death. The operation cannot possibly be more dangerous than the abscess, and although a large number will die on account of the extensive injury attending the lesion, yet every patient rescued is one rescued from the grave.

The head should be shaved and disinfected, as described under the head of "Technique," and the trephining should be done at a point determined by the rules of cerebral localization rather than by the scar or the history of the lesion. Of course if there is a fistula discharging pus, this will lead directly to the abscess. The dura having been opened and the brain exposed, it will bulge to a considerable extent through the opening. The normal pulsation of the brain will be absent. To determine where the abscess is we may resort to puncture of the brain. For this purpose the grooved director is the best instrument to use. The hypodermic needle and the knife have both been used, but with either there is considerable danger of wounding the vessels, a danger which with the director is absent. This should be thrust, gently and carefully, straight forward into the brain in the chosen direction, and may safely be introduced to a depth of two or two and one-half inches, unless the abscess be previously reached. If no pus is found, the director should be withdrawn as nearly as possible in the line in which it entered, and a second puncture made in another direction. As soon as the abscess is reached, an incision should be made into it with a knife, and the opening should be enlarged by a pair of hæmostatic forceps, which are to be introduced with the blades closed and drawn out with them separated to a proper degree. The sharp spoon should then be used to remove the granulation tissue; but care should be taken not to do any unnecessary damage to the healthy brain. The abscess cavity is next washed out with a boric-acid solution, and a rubber drainage-tube is inserted. The tube should be brought out through an opening in the scalp, and should be secured to it by a stitch. The bone should not be replaced. If the first trephine open-

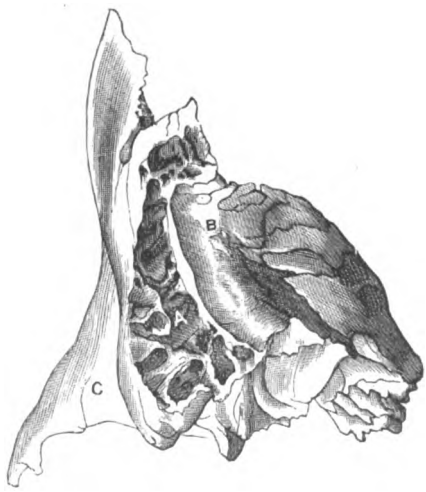
ing is not suitable for drainage a second should be made, the drainage tube being passed through both openings. An ample dressing should then be applied. As occasion requires, the drainage-tube should gradually be shortened until it can be removed. Sometimes there may be a re-accumulation of pus after apparent healing, when the wound must be reopened, the pus evacuated, and treatment instituted similar to that employed in the first instance. Occasionally such a re-accumulation will occur a long time after the primary abscess.

If the diagnosis is well assured and no abscess is discovered by the first trephining, the abscess may possibly be at some other point, and a second and possibly a third trephine opening should be made, in order by no possibility to miss it. Intracranial abscess is necessarily a fatal disease, and nothing should stand in the way of its evacuation if it can possibly be reached. The technique of evacuation of pus in the temporo-sphenoidal lobe and in the cerebellum, both frequent seats of abscess from ear disease, will be considered presently.

Diseases of the Brain Arising from Suppurative Disease of the Middle Ear.

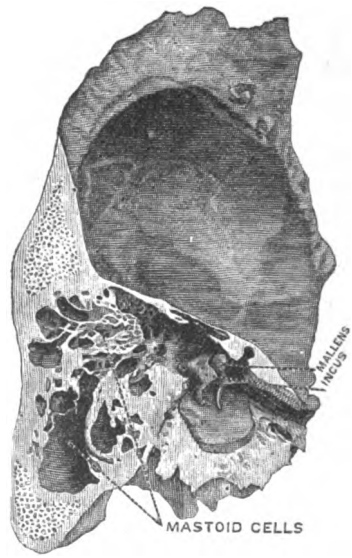
Anatomy.—If we look into a skull, we will be struck with the fact that the petrous portion of the temporal bone forms a boundary between

Fig. 1685.



Mastoid Portion of Left Temporal Bone Laid Open and Viewed from Behind. *A*, mastoid cells extending from the mastoid process below, upward and inward over *B*, the lateral sinus; *C*, the zygoma. (Burnett.)

Fig. 1686.



Section of Mastoid Process Showing the Mastoid Cells and their Communication with the Middle Ear.

the middle and posterior fossæ. Its upper edge, along which runs the superior petrosal sinus, forms the crest of a "watershed," with a moderate declivity forward toward the middle fossa for the temporo-sphenoidal lobe, and a very sharp declivity backward into the posterior fossa for the cerebellum. Again, on the inside of the mastoid portion

of the temporal bone runs a deep groove for the lateral sinus, which terminates in the internal jugular vein. Moreover, a section of the mastoid process and adjacent portion of the petrous part of the temporal bone shows that the layer of bone between the tympanum and the middle fossa (Figs. 1685, 1686), and also between the mastoid cells and the groove for the lateral sinus in the posterior fossa, is exceedingly thin. It is evident, therefore, that this bone in either of these places may readily become carious and be perforated in disease of the middle ear, and be the cause of thrombosis of the lateral sinus and the jugular vein, or of abscess either of the temporo-sphenoidal lobe or of the cerebellum.

PATHOLOGY.—Barker estimates that in Great Britain, with only one-half the population of the United States, there are probably 2000 deaths annually from ear disease; and of this number a large proportion is caused by the cerebral complications of that affection. Of 43,730 cases of ear disease tabulated by Bürkner, 66.9 per cent. were of disease of the middle ear, and 29 per cent. were of suppurative disease of the same part. Four-fifths of these were chronic cases, and it is among these especially that the brain lesions developed. Koerner[1] showed that in 100 cases of cerebral abscess arising from ear disease, 62 existed in the cerebrum and 32 in the cerebellum, and that in 6 both the cerebrum and the cerebellum were involved. He gives also the following table as to ages:—

Age.	Cerebrum.	Cerebellum.	Total.
Up to 10 years	12	2	14
11–20 "	13	9	22
21–30 "	19	10	29
31–40 "	11	3	14
Over 40 "	7	5	12
	62	29	91

showing that under 10 years of age cerebellar disease is comparatively rare. This is explained, according to Hartmann, by the fact that the distance of the posterior fossa of the skull from the organ of hearing is greater in children than in the adult. Such abscesses are much more common in the male than in the female, and also much more common in the cerebrum than in the cerebellum, as shown by the following figures (Koerner):—

Sex.	Cerebrum.	Cerebellum.	Total.
Male	43	18	61
Female	18	12	30
	61	30	91

The right side also is more frequently affected than the left in the proportion of 59 to 38 cases, both sides being involved three times. These abscesses will of course lie either near to or next to the bone, that is, will be either in the temporo-sphenoidal lobe or in the cerebellum. Only 7 of Koerner's 100 cases were situated elsewhere.

Naturally it would be presumed that if the discharge from the ear were very fetid it would be more dangerous than if the pus were without any such odor. But Rohrer has shown undoubtedly that non-fetid dis-

[1] Die otitische Erkrank. d. Hirns, d. Hirnhäute, und d. Blutleiter, 1894.

charges are the cause of the most dangerous cerebral complications, because the fetor is due to saprophytic rather than to pathogenic bacilli; many of the inodorous discharges, especially in the case of inspissated pus often found in the ear (cholesteatoma), are the most dangerous of all, being filled with pathogenic organisms.

Very rarely does cerebral disease of any kind follow acute inflammation of the ear. Terrillon [1] records a case of cerebral abscess from acute osteomyelitis of the skull. Truckenbrod [2] reports a case from acute otitis, with aphasia, agraphia, dyslexia, and convulsions of the right arm, which entirely recovered after operation. Jansen [3] records a case arising from acute otitis without any discharge. I have recently seen a similar case with Dr. S. MacCuen Smith at the Jefferson Medical College. The absence of external discharge is due to the non-rupture of the membrana tympani. Baginsky and Gluck [4] record an acute case following the insertion of a pea into the ear of a boy five years of age.

The explanation of the greater frequency of abscess in chronic cases given by Barker, is that in acute cases the mucous membrane lining the tympanum is not destroyed, and the underlying bone therefore is not affected and the disease is not propagated inward, but the deleterious products are adequately carried off by the lymphatics. But in chronic ear disease the walls of the tympanum consist of exposed and carious bone, containing numerous vessels which communicate with those of the dura mater. These cases are especially liable to septic phlebitis, which often leads to intracranial complications. In these chronic cases the disease has to be stimulated afresh before it becomes dangerous, the new infection apparently developing especial virulence. Mr. Barker [5] points out that in the course of chronic otorrhœa, which may have existed for years with but little trouble, patients become suddenly very ill immediately after measures have been taken for clearing out the middle ear. The new inflammation apparently is developed by incomplete cleansing of the septic cavities, thus setting free all the dangerous material which was in the inspissated pus, and which finds a ready opening into the blood-vessels and lymphatics by the breaking-down of the barriers which had previously existed. Hence all such cases should be subjected to a course of most careful antiseptic treatment before operative interference, and the operation should be thoroughly done.

Sometimes aural disease produces an abscess at a distance of an inch or two from the inferior surface of the brain, the intervening cortex remaining perfectly normal. The explanation, according to Mr. Barker, is that a thrombus extends into the lateral or the petrosal sinus, and from these into the veins of the interior of the brain, especially as these veins have no valves; or, secondly, that the blood-current may be reversed in these veins by reason of the thrombus.

OTHER CEREBRAL COMPLICATIONS ARISING FROM DISEASE OF THE MIDDLE EAR.—These are chiefly meningitis, subdural abscess, extradural abscess, cerebral abscess, cerebellar abscess, and thrombosis of the lateral sinus.

[1] Bull. et Mém. de la Société de Chirurgie, Paris, tome xv., p. 555.
[2] Archives of Otology, vol. xxi., No. 2.
[3] Berl. klin. Wochenschr., 1891, No. 48. [4] Ibid.
[5] Hunterian Lectures on Intracranial Inflammations starting in the Temporal Bone, p. 16. London, 1890.

(1) *Meningitis.*—Meningitis following disease of the ear differs in no respect in its symptoms from meningitis arising from any other cause, saving that it is more likely to be localized, and may be more frequently relieved by operation. The differential diagnosis from abscess may be made with considerable accuracy by noting the fact that the pain is much sharper and more general in meningitis, especially if it be diffused, while that of abscess is duller and more local. The patient's mental condition in abscess is marked by hebetude, while in meningitis there is apt to be delirium even early in the case. The temperature in meningitis will be very high, with slighter fluctuations than in pyæmia or thrombosis of the lateral sinus, and in marked contrast to the subnormal temperature of abscess. If the meningitis be localized, however, the temperature will probably not be very high, and will fluctuate but little; in other words, it approaches that of abscess. The pulse in meningitis will be rapid and of small volume, and often irregular, and in marked contrast again to the slow pulse of abscess. In meningitis also the bowels are apt to be constipated while diarrhœa often accompanies the pyæmic manifestations of sinus thrombosis. Optic neuritis is not present with such regularity that it can be depended upon as a differential symptom. Photophobia and intolerance of noise, flushed face and contracted pupils, all would look toward meningitis rather than abscess.

(2) *Subdural Abscess.*—If the meningitis be a localized one it may very possibly lead to a subdural abscess, that is, an abscess between the dura and the brain. Two localities are the commonest for such abscesses (Barker). The first, especially in children, is the neighborhood of the petroso-squamosal suture above. The next and most serious is the sulcus lateralis, or groove for the lateral sinus, below. From the first point the abscess may extend into the lateral sulcus, but may also spread upward and backward over the inner surface of the squamous portion of the temporal bone, and may even perforate, first the dura and then the squamous portion of the temporal bone, commonly behind the meatus, when it may be mistaken for an ordinary periosteal abscess; or, as in a case recently reported by MacCuen Smith, it may burst through the squama in front of the ear, or may burst through the tympanum and drain through the meatus itself. If the subdural abscess form in the lateral sulcus it may escape by the mastoid foramen, but is more likely to involve the lateral sinus and be followed by fatal thrombosis and pyæmia. But in both varieties there may be produced a widespread septic meningitis, which will lead to death unless the surgeon interfere early. The symptoms of such a subdural abscess will be those of meningitis already described, but in addition to these there may be valuable localizing symptoms, either of convulsions, paresis, or paralysis, involving the face, arm, or leg, according to the location and size of the abscess.

Treatment.—In a diffused meningitis it is doubtful at the present time whether operative interference is justifiable, although the tendency of surgical practice is rather toward than from operation. But in cases of localized meningitis, especially in that form which leads to subdural abscess, an operation should certainly be resorted to, and it should be both early and thorough. If the diagnosis, as is often the case, is doubtful, in view of the gravity of the prognosis the patient

should have the benefit of the doubt by an exploratory operation. Opening the dura, if it has not already been perforated, will prove whether a subdural abscess is present or impending, or not.

Mr. Barker, I think, is quite right in proposing that in such cases the trephine should be used over the lower anterior part of what he has well called the "dangerous area." This is a circle with a one-and-a-quarter inch radius, with its centre an inch and a quarter behind and the same distance above the middle of the external meatus. After exposing the dura and opening it, the state of the serous surfaces will determine whether any further steps should be taken or not. If meningitis of the more plastic form be present, Mr. Barker recommends that several circles of bone should be removed in order to cleanse and drain the surface of the brain thoroughly. But in those cases in which there are definite localizing symptoms, the spot indicated by these symptoms should be reached by puncture. The most remarkable illustration of this is in an admirable case reported by Mr. Barker,[1] in which he evacuated an ounce of odorless pus from the fissure of Sylvius, next to the island of Reil, with the happiest result. The cavity of the abscess may be irrigated, and drained or not, according to the conditions found.

(3) *Extra-Dural Abscess.*—In these cases the abscess almost always arises as a result of caries of the petrous bone after disease of the ear. Here the question of diagnosis, especially the differential diagnosis from subdural abscess and thrombosis of the lateral sinus, is a matter of great difficulty. The temperature, however, will usually distinguish extra-dural from cerebral or cerebellar abscess, as in the former it rises to from 102° to 104° F. The pain is usually fixed above and behind the ear, with marked tenderness on percussion and pressure in the same region. Not uncommonly also there is œdema of the scalp. There may be sometimes choked disc and symptoms of cerebral pressure if the abscess reaches any considerable size. Many years since[2] I reported a remarkable case in which the entire petrous bone became necrotic and was removed. The carotid must have been obliterated. All the special senses except touch were destroyed, and the child was reduced to an idiotic condition. (Fig. 1687.)

Fig. 1687.

Necrosis of Petrous Bone.

Treatment.—The mastoid will probably already have been opened, but if not, this should be done immediately. If there is a fistula from rupture of the abscess through the bone, this will lead to the abscess. Trephining should be done at the same point as already indicated, and the dura mater should be laid bare, care being taken, of course, not to wound the lateral sinus. If this should be involved, it should be treated as pointed out below. The abscess cavity having been reached, should be irrigated with an antiseptic solution and curetted, any necrosed or carious bone should be removed, and free drainage should be provided. Bircher[3] relates a remarkable case in which he chiselled away all the necrotic petrous bone except the carotid canal, and saved his patient. Hoffmann[4] gives a table of 102 fatal cases in

[1] British Medical Journal, 1888, vol. i., p. 771.
[2] Philadelphia Med. Times, June 15, 1871.
[3] Centralbl. für Chirurgie, 1893, S. 482.
[4] Deutsche Zeitschr. für Chirurgie, Bd. xxviii., S. 484.

which the diagnosis was only made after death. He tabulates 10 other cases in which the diagnosis was made during life, in which 8 patients recovered after operation. No comment upon such figures is necessary.

(4) *Cerebral Abscess.*—Nine-tenths of all cerebral abscesses lie again in the "dangerous region." They are more commonly encapsulated than diffused. In 100 cases reported by Koerner,[1] 62 occurred in the cerebrum, 32 in the cerebellum, and 6 in both.

Diagnosis.—The otitis which causes cerebral abscess is almost always chronic. In 57 cases reported by Pitt,[2] only two had existed for less than a year. There is usually a sudden cessation of the discharge, with an initial rise of temperature, nausea and vomiting, and dull pain in the mastoid region, radiating to the temples and the neck. The pulse becomes rapid, the tongue coated, and very often there is diarrhœa. All this points to an acute septic infection engrafted on a long existing saprogenic suppuration. The headache or tenderness is often general, or frontal, and not located at the site of the lesion. After the initial rise the temperature falls to the normal, or more commonly becomes sub-normal. The pulse becomes very slow, often falling to 30 or 40. The intellect becomes dull and sluggish and the hebetude gradually deepens into coma. The bowels are apt to be constipated, the breath fetid, and the skin muddy, while rapid emaciation is a marked symptom. Optic neuritis is of value if present, but is often absent. The localizing symptoms, as shown either by localized convulsions, paresis or paralysis, aphasia, etc., if present, are of the greatest value. The state of the pupil is not commonly a reliable symptom.

The contents of these abscesses vary much in character, being in some cases a thick, greenish, and exceedingly fetid pus, and in others a thin, pale, odorless fluid, which is scarcely purulent.

Differential Diagnosis between Cerebral and Cerebellar Abscess.—The distinction between these is extremely difficult, but equally important, if it can be made, since upon it depends whether we shall trephine and explore the temporo-sphenoidal lobe or the cerebellum. In case the diagnosis cannot be made with reasonable certainty it is always best to explore first the temporo-sphenoidal lobe, and, if no abscess is found, then immediately to explore the cerebellum. Possibly tenderness on percussion over the site of the abscess may guide us, although spontaneous pain is of very little worth. Vertigo is apt to be present in both conditions, but the want of co-ordination in cerebellar cases is rarely present, and from the mental hebetude and bedfast condition of the patient its presence often cannot be ascertained. Optic neuritis may be present in both forms. Disturbances of speech are of the greatest importance, since they point definitely to the third frontal convolution, usually on the left side in right-handed persons.

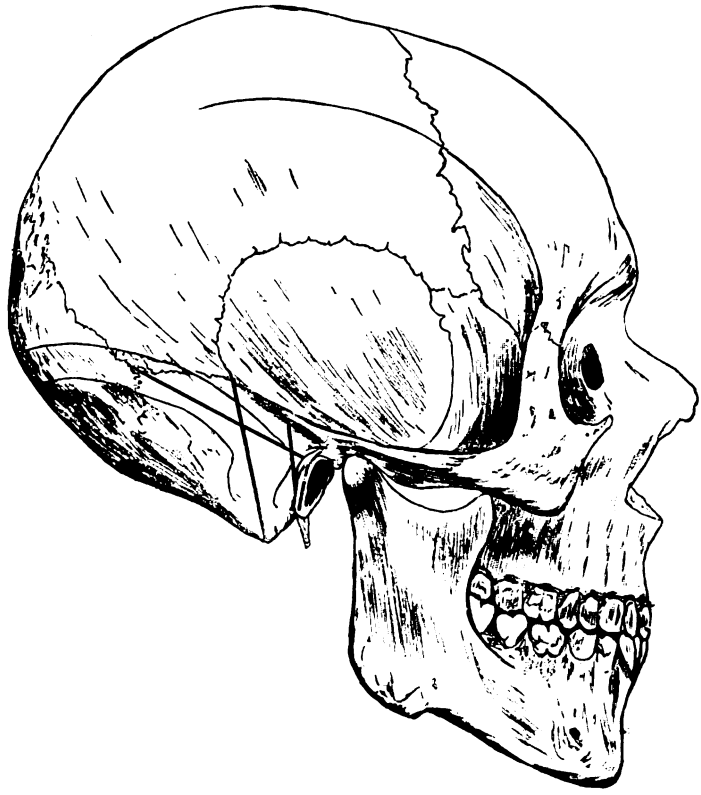
Similarly hemiplegia would point distinctly to the motor area of the cerebrum rather than to the cerebellum. Koerner mentions crossed facial paralysis as present in 2 out of 100 cases of cerebral abscess, but it was also present in one case of cerebellar abscess. Facial paralysis on the same side as the diseased ear is no indication of localizing value, since it is caused by a direct lesion of the seventh nerve as it passes through the aqueduct of Fallopius of the diseased ear itself, and has no relation to the cerebral or cerebellar abscess.

[1] Arch. für Ohrenheilkunde, Bd. xxix., S. 15. [2] Brit. Med. Jour., 1890, vol. i., p. 643.

Treatment.—The treatment in many respects is the same as that already indicated for brain abscess in general, but there are some special indications of importance.

Mastoid Operations.—In any case of long-standing disease of the ear, if persistent headache, vomiting, or mental dulness occur, without any permanent rise of temperature, the external meatus should first be thoroughly cleansed antiseptically, and then the mastoid should be opened by a longitudinally curved incision posterior to the ear, from the base of the mastoid to its tip. The mastoid antrum and the mas-

Fig. 1688.



Surface Guides for the Sigmoid Sinus and the Supra-Meatal Triangle (Macewen). The three artificial lines drawn upon the skull indicate the following: (1) The short vertical line from the posterior border of the external auditory meatus to the posterior root of the zygoma marks the base of the supra-meatal triangle. The broken line indicates the anterior border of the supra-meatal triangle. The third side of the triangle is the root of the zygoma. The broken line also indicates the course of the facial nerve. (2) The second vertical line, extending from the parieto-squamo-mastoid junction to the tip of mastoid, in the upper two-thirds of its length indicates the position of the sigmoid sinus (the curved portion of the lateral sinus). (3) The oblique line, passing from the asterion to the upper limit of the external auditory meatus, indicates in its posterior two-thirds the sigmoid sinus from its commencement to its knee or bend.

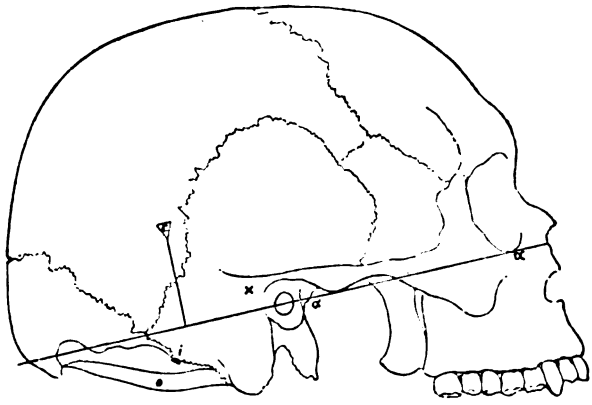
toid cells should be thoroughly opened by the gouge and chisel, and the posterior wall of the meatus itself should be chiselled away to the cavity of the middle ear. In order to reach the mastoid antrum, an opening should be made one-third or one-half an inch behind, and the same distance above, the centre of the meatus. The mastoid cells lie between the antrum and the apex of the mastoid. All the inspissated pus found should be removed by a sharp spoon or with the gouge,

care being taken, of course, not to wound the lateral sinus and also not to go so deep as to injure the facial nerve. The anæsthetizer should be notified to watch for any twitching of the facial muscles, and to warn the operator of his proximity to the nerve as shown by this symptom. The nerve is not commonly encountered. As an antiseptic, up to this point, the ordinary 1–1000 sublimate solution may be used, and the cavity may be lightly packed with iodoform gauze.

Macewen [1] has called attention to what he has denominated the supra-meatal triangle. (Fig. 1688.) This triangle is bounded above by the root of the zygoma; in front by the posterior wall of the meatus, and posteriorly by a line uniting these two. In most skulls (about 94 per cent.) as soon as the bone is bared, this triangle is perceived as a shallow depression. The antrum always lies within this triangle, and the sigmoid sinus, that is, the curved part of the lateral sinus, always lies posterior to it.

If these operative measures do not soon relieve the symptoms, and especially if the hebetude deepens and if localized convulsions or paralysis occur, with rapid emaciation, subnormal temperature, and

Fig. 1689.



Landmarks for Incision for Abscess of Brain. *aa*, Reid's base line; *c*, point at which to trephine for abscess of the temporo-sphenoidal lobe 1¼ inches behind the meatus and 1¼ inches above Reid's base line; *i*, foramen for mastoid vein; *o*, point of trephining to reach cerebellum; *x*, site of mastoid antrum ¼ inch behind and above external auditory meatus. (Barker.)

slow pulse, it is almost certain that the condition has gone beyond mere mastoid disease, and that an abscess has been developed. This, if in the temporo-sphenoidal lobe, is best reached by applying a half-inch trephine at a point an inch and a quarter behind the external auditory meatus and an inch and a quarter above Reid's base line, which is a line drawn from the inferior border of the orbit through the middle of the external meatus. This is the point chosen for trephining by Barker (Fig. 1689, *c*), and has the advantage that if no abscess be found, it is far enough away from the ear and mastoid to be protected from septic infection. The dura having been exposed, it should be opened by a crucial incision. If an abscess is present the probabilities are that the brain will bulge and not show any pulsation. A grooved director should next be inserted in the axis of the temporo-sphenoidal

[1] Pyogenic Infective Diseases of the Brain and the Spinal Cord.

lobe, which is, as I have shown,[1] downward, forward, and inward, in the direction of the opposite wing of the nose. If this puncture is futile several other punctures may be made in suitable directions, as multiple punctures do but little damage, and, compared with that caused by an abscess, none whatever. When the abscess is found, the cavity should be treated as already described.

It is always well in these cases to explore the opening for the mastoid vein (Fig. 1689, *i*), which lies about an inch back of the mastoid process. If pus is found oozing from this opening, as the vein empties into the lateral sinus, it is certain that there is pus in the groove for the lateral sinus, and the latter should then be well exposed by the rongeur, gouge, and chisel. The treatment of the sinus is described below.

(5) *Cerebellar Abscess.*—The differential diagnosis of cerebellar abscess has already been given. The general diagnosis is very much the same as that for cerebral abscess, saving that choked disc is very rarely present, and that the temperature is apt to be high from complications. If present, the abscess is apt to be situated in the anterior part of the lateral lobes, where they are in contact with the petrous bone and the groove for the lateral sinus.

Treatment.—The cerebellum may be reached at a point midway between the mastoid and the inion, and sufficiently far below the line from the meatus to the inion, which corresponds to the lateral sinus, to avoid wounding the sinus. (Fig. 1689, *o* and *x*.) A semilunar incision should be made with convexity upward, the occipital bone exposed at the selected point, and then either trephined or opened by means of the chisel, which is preferable both from the irregularity as well as from the lessened thickness of the bone. In children a simple gouge will penetrate the skull very readily and the rongeur will enlarge the opening at will. If the cerebellum bulges and pulsation is wanting, it is almost certain that an abscess is present. Not only the lobe of the same side on which the opening is made can be reached by the grooved director, but the opposite lobe can be explored by an oblique puncture. Care should be taken not to injure the superior vermiform process.

(6) *Thrombosis of the Lateral Sinus.*—One of the most brilliant chapters relating to the cerebral complications of ear disease is the modern treatment of thrombosis of the lateral sinus. It is only since 1884 that this condition has been diagnosticated during life and treated with success.

The frequency and the danger of the disorder can be appreciated from the statement that Mr. Ballance estimates that in London alone there is from this cause one death a week, and that Pitt[2] says that in 20 years at Guy's Hospital, in 57 autopsies of those dying from ear disease, 22 showed thrombosis of the lateral sinus, in more than half it was suppurating, and in 11 cases the thrombus extended into the jugular vein. In all of these pulmonary infection existed. In 4 cases the thrombus extended into the longitudinal, and in 3 into the opposite lateral, sinus. The proximity of the lateral sinus to the mastoid and the thin layer of bone separating it from the mastoid cells and antrum have already been alluded to. (Figs. 1685, 1686, p. 590.)

Symptoms and Diagnosis.—As in other complications of aural dis-

[1] Buck's Reference Handbook Med. Sciences, vol. viii., p. 216.
[2] Brit. Med. Journal, 1890, vol. i., p. 643.

ease, there may have been a chronic otorrhea. But it must not be forgotten that if the membrana tympani is intact there will be no discharge from the ear, and yet cerebral pyæmia and sinus thrombosis may follow the otitis media and destroy life. Pitt[1] says that in 9 cases out of 57 (16 per cent.), sinus thrombosis without external discharge from the ear was the cause of death. In either case an acute illness arises, characterized by headache, pain in the region of the sinus, distinct and repeated rigors, sweats, and violent oscillations of temperature; in other words, all the ordinary evidences of pyæmia which would naturally be expected to follow a septic thrombus in so large a venous sinus. Usually there will be tenderness and œdema over the mastoid, with tenderness over the sinus itself, that is, in a line from the external auditory meatus to the inion. Bennett[2] has called especial attention to what he deems a pathognomonic symptom, viz.: tenderness over the mastoid vein (Fig. 1689, *i*), and has termed it "post-mastoid tenderness." It exists even when there is no tenderness over the mastoid itself. In addition to this, as has already been mentioned, since the thrombus often extends still farther in the direction of the blood-current into the internal jugular vein, tenderness and other inflammatory manifestations will be found also in the neck in the course of that vein, that is, along the anterior border of the sterno-cleido-mastoid muscle. In consequence of the formation of the clot, the vein will be felt as a tense and tender cord, unless, as often occurs, a periphlebitis has developed, which will cause a more widespread brawny hardness. In some cases, indeed, the vein is entirely destroyed, and there may be developed an abscess in the neck. In one of Bennett's cases[3] the wall of the jugular vein was broken down, and the abscess communicated with the lumen of the vessel. In my own case the vein was recognized with great difficulty, being almost lost in the matted tissues of the neck. Shield[4] reports a case of thrombus extending into the veins at the root of the nose, and Lanciol[5] two cases of thrombosis of the cavernous sinus. Choked disc is almost invariably present in sinus thrombosis. Care must be taken not to mistake the disease for typhoid fever, especially as there are often severe headache and otorrhea in the early stages of that affection. The violent oscillations of temperature and choked disc in sinus thrombosis, the different prodromata, and the abdominal symptoms and rose spots in typhoid fever, will afford the means of differential diagnosis.

Not only may there be thrombosis of the lateral sinuses, but occasionally the petrosal and the cavernous sinuses are involved. Thrombosis of the former has no local symptoms by which it can be determined, but in the case of the latter, from the thrombosis blocking the ophthalmic vein, there may be hyperæmia of the retinal veins with extensive œdema of the frontal veins and lids, and exophthalmos from retrobulbar œdema. From the pressure on the nerves in the cavernous sinus we may have also neuralgia of the first division of the fifth nerve, and paralysis of the abducens (sixth), patheticus (fourth), or motor oculi (third) nerve. But any one or even all of these local symptoms may be absent. Occasionally also there may be a true pyæmia without thrombosis of any of the sinuses.

[1] Loc. cit. [2] Lancet, 1893, vol. ii., p. 619. [3] Loc. cit.
[4] Archives of Otology, vol. xxi., No. 7. [5] Centralbl. f. Chir., 1892, S. 238.

Treatment.—In 1880 Zaufal[1] was the first to suggest the proper treatment of this, until then, almost uniformly fatal disease, and he was the first to carry it into effect in 1884. (See table.) In 1886 Horsley[2]

THROMBOSIS OF THE LATERAL SINUS.

Author.	Reference.	Recov.	Died.	Total.
Zaufal	Prag. med. Wochen., 1884, 474 and, 1891, No. 28	..	1	1
Hoffman	Deutsch. Zeitschr. f. Chir., 1888, xxviii. 484	1	..	1
Orlow	Deutsch. med. Wochen., 1889, 193	1	..	1
Ballance	Lancet, 1890, i., 1057	2	2	4
Keen	Times and Register, Dec. 20, 1890, 559	..	1	1
Salzer	Wien. klin. Woch., 1890, iii., No. 34	1	1	2
Keetley	Lancet, 1890, i., 1116	..	1	1
Moos	Arch. Otol., 1890, xix., 163	1	..	1
Schwartze	Handb. der Ohrenheilk., ii., 1890, 844	2	2	4
Makins	Lancet, 1891, i., 1259	2	..	2
Weigel	Zur Pathog. u. Therap. d. Thromb. des. Sinus. Transv. Jena, 1891	1	1	2
Poulson	Nordiskt medicin, Arkiv, 1891, xxxiii, 45	..	1	1
Hansberg	Monatschr. f. Ohrenheilk., 1892, Nos. 1 u. 2	..	1	1
Politzer	Laurent, Intervention Chirurgicale dans les lésions du Cerveau, 1892	1	..	1
Parker	Liverpool Med.-Chir. Jour., 1892, xii., 86	1	1	2
Clutton	Brit. Med. Jour., 1892, i., 807	1	..	1
Lane	Lancet, 1892, ii., 1044	..	1[3]	1
Pritchard	Lancet, 1893, i., 471	1	..	1
Parkin	Lancet, 1893, i., 522	2	..	2
Shield	Arch. of Otology, xxi., 3	..	1	1
Lane	Brit. Med. Jour., 1893, ii., 561	8	2	10
Jones	Brit. Med. Jour., 1893, ii., 563	..	1	1
Bennett	Lancet, 1893, ii., 619	1	1	2
Beck	Pathol. u. Chir. des Gehirns., 1893, 26 und 29.	..	2	2
Forselles	Eitrige Mittelohrentzündung von Lateralsinus-Thrombose, 1893, ii.. 118	.	3	3
Macewen	Pyogenic Infective Diseases of the Brain and Spinal Cord, 1893, 332	16[1]	4	20
Ballance	Brit. Med. Jour., 1893, ii , 1274	1	..	1
Vickery	Brit. Med. Jour., 1893, ii., 1144	1	..	1
Scott and Lane	Lancet, 1893, i., 138	1	..	1
Sonnenberg	Centralbl. f. Chir., 1893, 443	1	..	1
Bircher	Centralbl. f. Chir., 1893, 483	1	..	1
Buck	Med. Record, June 30, 1894, 810	1	..	1
Grünert	Centralbl. f. Chir., 1894, 211; from Arch. f. Ohrenheilk., xxxvi	1	..	1
Cleghorn	Brit. Med. Jour., 1894, i., Epit., 70	1	..	1
Schwabach	Brit. Med. Jour., 1894, i., Epit., 57	..	1	1
Crockett	Med. Record, June 9, 1894, 741	1	..	1
Miller	Brit. Med. Jour., 1894, ii., 71	1	..	1
Herczel	Wien. Med. Woch., 1894, No. 98	1	..	1
Walker	Lancet, 1894, ii., 1160	1	..	1
Milligan & Brown	Lancet, 1894, ii., 1427	1	..	1
Walker	Brit. Med. Jour., 1895, i., 806	1	..	1
Milligan	Lancet, 1895, i., 984	2[2]	..	2
		58	28	86

[1] Three of these were cases of thrombosis of the longitudinal and not of the lateral sinus.
[2] One of these was a case of thrombosis of the cavernous sinus, secondary to ear disease.
[3] Not apparently included in the 10 cases in the British Medical Journal, 1893, ii., 561.

urged the same treatment anew. These suggestions soon bore abundant fruit. Mr. Arbuthnot Lane[3] reported a case of rapid recovery fol-

[1] Prag. med. Woch.
[2] Trans. Clin. Soc., vol. xix., p. 255.
[3] Brit. Med. Journal, 1889, i., 997.

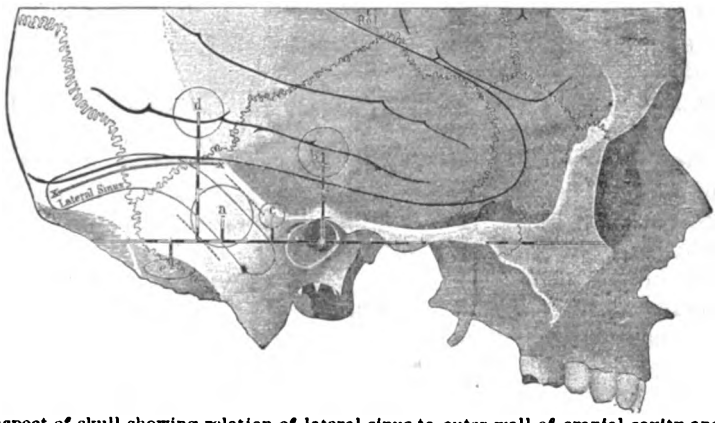
lowing Horsley's mode of treatment, and has since reported 10 such cases operated on, with 8 recoveries[1] while Ballance[2] reported 4 cases with 2 recoveries. Other cases have been recorded by various surgeons, and, as far as I have been able to collect them by a fairly thorough search, are included in the preceding table.

My own case,[3] Buck's, and Crockett's are, I believe, the only cases thus far reported in American medical literature. I can only attribute this to the fact that the condition has been unfortunately overlooked.

This makes a total of 86 cases with 58 recoveries and 28 deaths, a mortality of less than one-third. This is a most encouraging result when we remember that the operation is so recent, and that without operation every patient would have died.

Treatment.—This cannot be too prompt or too thorough. Imperfect operations in which the lateral sinus is exposed but not opened, such as some of those of Hansberg,[4] Chauvel,[5] and others, should not be practised

Fig. 1690.



Lateral aspect of skull showing relation of lateral sinus to outer wall of cranial cavity and position of trephine opening (*a*). 1 inch behind bony meatus and ¼ inch above Reid's line. Reid's base line from lower border of orbit through middle of external meatus is made to a scale of 8ths of an inch, as are also the lines perpendicular to it. (Rol.) lower end of fissure of Rolando; XX sight of tentorium, in part. The anterior X shows the point where the tentorium leaves the side of the skull to be attached to the superior border of the petrous bone; (*c*) corresponds to mastoid antrum, ½ inch behind meatus and ¼ inch above Reid's base line; (*b*) trephine opening ⅞ inch above meatus, to explore anterior surface of petrous bone; (*d*) trephine opening for temporo-sphenoidal abscess, 1¼ inches behind meatus and 1¼ inches above Reid's base line; (*e*) trephine opening for cerebellar abscess, 1¼ inches behind meatus and ¼ inch below Reid's base line. (Ballance.)

in view of the later and better results from more thorough operations. The mastoid antrum and often the cells also, if not already operated on, should be opened and cleansed. Next the lateral sinus should be exposed, either by the chisel or the trephine, at a point one inch behind and a quarter of an inch above the middle of the external auditory meatus (Fig. 1690, *a*). The opening may be enlarged either by the rongeur or by the chisel and gouge. Pus will very likely be found in the groove for the sinus. If this be the seat of thrombosis it will feel hard to the touch. If no thrombus has formed it will be soft. In either case, if the symptoms warrant it, the sinus should be incised. If no thrombus is found the blood will of course escape profusely, but may be instantly arrested by the finger. Strips of iodoform gauze should

[1] Brit. Med. Journal, 1893, vol. ii., p. 561.
[2] Lancet, 1890, vol. i., pp. 1057–1114.
[3] Med. Times and Register. Dec., 1890, p. 559.
[4] Ann. des Mal. de l'Oreille, etc., 1892, p. 1.
[5] Centralbl. f. Chir., 1893. S. 236.

have been provided, and the sinus should be immediately plugged with them. If a clot is found it will be apt to be excessively foul, and the sinus must be freed from this septic mass by a small spoon or curette. The sinus should then be disinfected thoroughly. This cleansing and disinfection may have to be extensive. To do any good it must evidently be coextensive with the infected and infecting clot. We must therefore continue to curette the sinus until free hemorrhage shows that all the clot has been removed. Packing of the sinus after its free disinfection will easily arrest the bleeding. Parkin[1] boldly but wisely curetted as far as the torcular Herophili and saved his patient. In one of Ballance's cases[2] the lateral sinus came away as a slough. It must be remembered that one sinus may be the seat of thrombosis as far as the torcular without involving that of the opposite side, since the two lateral sinuses are not usually continuous. The right sinus at the torcular is usually continuous with the superior longitudinal sinus, and the left with the straight sinus, while a separate sinus or a small cross branch connects the two lateral sinuses. In St. Thomas's Hospital Museum is a skull with a groove for the sinus on only one side (Ballance). This cleansing of the sinus, it must be remembered, can do no harm, since the blood current is already arrested by the existing clot, the circulation being carried by other venous channels. Sometimes ligation of the sinus would be proper.

The internal jugular vein should next be exposed in the neck and ligated at a point below the thrombus, the extent of which can usually be determined by touch. This step is of the greatest importance, as, if done sufficiently early and sufficiently low down, it will prevent extension of the clot into the lungs. This involvement of the lungs is the greatest danger which threatens the patient. If they become infected the case is hopeless. The vein should then be cut above the ligature and the upper end should be attached to the skin, the vein and the sinus being washed out as thoroughly as possible in order to arrest the septic process.

Tumors of the Brain.

Until 1885 no attempt had been made accurately to locate or remove a tumor of the brain. Prior to that year the diagnosis of the presence of a tumor was fairly clear in most cases, but to locate it exactly was (and unfortunately in many cases still is) difficult and uncertain, and its removal was regarded as impossible. When, therefore, Bennett and Godlee[3] reported that they had successfully located and removed a tumor not visible on the cerebral cortex, the surgical world was startled. Since then a large number of tumors have been removed, a considerable number sought for and unfortunately not found, and several found and not removed. Of the patients from whom brain tumors have been removed over two-thirds have recovered.

Causes.—The causes of tumors of the brain are as a rule unknown. A number of cases have been reported in which injury has been the pre-

[1] Lancet, 1893, vol. i., p. 522.
[2] Ibid., 1890, vol. i., p. 804.
[3] Med. Chir. Trans., 1885, vol. lxviii., p. 243.

sumptive cause. This usually gives rise to sarcoma, and more rarely to fibroma. In this country parasitic tumors of the brain, echinococcus or actinomycosis, are rare, although in Australia and Germany a considerable number have been reported, 88 cases by Kuchenmeister alone.

PATHOLOGICAL ANATOMY.—The largest statistics as to the frequency and variety of brain tumors in children and in adults are those given by Starr,[1] who has collected 300 cases in either category.

STARR'S TABLE OF 600 BRAIN TUMORS—300 IN ADULTS AND 300 IN CHILDREN.

Situation.	Tuberculous.		Glomatous.		Sarcomatous.		Glio-sarcomatous.		Cystic.		Carcinomatous.		Gummatous		Not Stated.		Total.	
I.—Cerebral axis.																		
1. Basal ganglia and lateral ventricles	14	3	3	9	5	8	..	..	1	1	1	2	..	1	3	5	27	29
2. Corpora quadrigemina and crura cerebri	16	1	1	2	3	2	.	5	..	..	..	1	..	..	1	7	21	18
3. Pons	19	11	10	..	5	1	2	1	1	..	..	2	..	3	1	..	38	18
4. Medulla	2	..	..	1	..	..	..	..	1	..	2	..	..	..	1	..	6	1
5. Base	..	3	..	2	1	3	1	1	1	..	1	..	..	..	4	1	8	10
6. Fourth ventricle	1	.	1	..	1	1	..	..	..	..	1	2	.	..	1	1	5	4
II.—Cerebellum	47	8	15	8	10	13	1	6	9	..	3	..	..	..	11	10	96	45
III.—Multiple tumors	34	4	..	2	3	5	..	..	2	..	..	2	1	3	3	1	43	17
IV.—Cortex cerebri	13	9	6	19	1	46	..	8	..	1	1	19	..	13	.	12	21	127
V.—Centrum ovale	6	2	1	11	5	7	1	4	15	..	1	3	1	..	5	4	35	31
	152	41	37	54	34	86	5	25	30	2	10	31	2	20	30	41	300	300

The first columns are children's tumors, the second columns adults' tumors.

The table of Seguin and Weir, taken from Hale White and Bernhardt, gives percentages of the characters of the various tumors:—

SEGUIN AND WEIR'S TABLE OF 580 BRAIN TUMORS

	Number.	Per cent.
Nature of tumor not stated	133	22.9
Tubercular tumors	137	23.0
Gliomata	76	13.0
Sarcomata (including cysto-sarcomata)	75	13.0
Hyuatids, cysticerci, echinococci	30	5.0
Cysts	27	4.6
Carcinomata	24	4.0
Gummata	21	3.6
Glio-sarcomata	14	2.2
Myxomata (including myxo-sarcomata)	12	2.0
Osteomata	6	+ 1.0
Neuromata	4	— 1.0
Psammomata	4	— 1.0
Papillomata	4	— 1.0
Fibromata	3	
Cholestomata	2	
Lipomata	2	
Erectile or vascular tumors	2	
Dermoid cysts	2	
Enchondromata	1	
Lymphomata	1	
Cases	580	

[1] Brain Surgery, p. 202.

It will be observed on comparing these tables that the tubercular tumors in Starr's table are 193 out of 600, nearly one-third. In the other table they are 137 out of 580, or 23 per cent., the larger percentage in Starr's table being due to the greater preponderance of tubercular tumors in early life, they being nearly four times as frequent in children as in adults. The proportion of the gliomata is not far from the same in each, and the percentage of sarcomata in Starr's table is slightly greater than in the other. It will be observed again on taking tubercular tumors, gliomata, sarcomata, and the glio-sarcomata together, that they constitute 434 out of the 600 in Starr's table and 302 in White and Bernhardt's table, which comprises 447 tumors of known character and 133 of unknown histology. The enormous proportion, therefore, of tubercular and the various kinds of sarcomatous tumors is very evident. Hence the presumption is in general greatly in favor of one of these two kinds of tumor being present. In childhood the presumption is in favor of either tubercular or gliomatous tumors; whereas in adults the sarcomata number far more than other varieties. Starr has recently called attention to the singular fact that so few gummata have been recorded in literature, and says that his impression, derived from clinical experience, is that gumma is the most frequent form of brain tumor occurring in adults. My impression is that this is going much too far, but that undoubtedly the number in Starr's table is proportionately far less than that of the gummata which are seen clinically. Inasmuch as they are influenced by specific medication, and are often either entirely cured or diminished to such an extent as to become innocuous, they rarely come either to operation or to the post-mortem table. This to a great extent explains their absence from statistics.

Statistics are often misleading, and apply only in a general way to any individual case, but yet they are of value as establishing a presumption. Given, for instance, an adult who has had an injury and is free from syphilis and tubercle, and the probabilities are very strongly in favor of sarcoma, or its congener glioma. If there be sarcoma in any other organ and marked cachexia, the presumption will be strongly in favor of a metastatic sarcoma of the brain. Or if there have been evidences of late secondary or of tertiary syphilis and no injury, the chances will be strongly in favor of gumma. Again, in a child, without injury, with an hereditary predisposition to tuberculosis, and especially if any other form of tuberculosis be present, the presumption is strongly in favor of a tubercular tumor, especially if there are any evidences pointing toward more than one tumor, or of a tumor in the cerebellum. If the tumor be a very vascular glioma, there may be sudden changes in the intensity of the symptoms, accompanied possibly by attacks of epilepsy of moderate degree, due to hemorrhage.

Von Bergmann has taken decided ground against attacking tubercular tumors, on the ground that it is impossible to remove them thoroughly. Horsley, whose opinion always carries double weight, is decidedly in favor of removing them, and Starr rightly favors attacking them just as the surgeon attacks a tubercular joint or a tubercular testicle. In gummata both Hale White and von Bergmann have opposed operation. On the other hand, Horsley, Seguin, and Starr are rightly in favor of their removal after the failure of specific treatment.

The limit for such treatment Horsley fixes at six weeks. Starr, I think with more justice, would extend it to three months: and I would urge with Seguin that no antisyphilitic treatment can be regarded as efficient unless the dose of the iodides has been increased up to half an ounce a day, or earlier intolerance.

The location of intracranial tumors is unfortunately such that as a rule they are not accessible to operation. Gowers has tabulated 637 such tumors as follows:

Central hemispheres (including central ganglia)	297
Cerebellum	179
Pons	59
Central ganglia	48
Medulla	31
Corpora quadrigemina	13
Crura cerebri	10
	637

In Starr's table (p. 603) it will be observed that in the cerebral axis there were in adults 105 tumors, in children 80, all of them being of course excluded from operation. In the cerebellum there were 96 tumors in 300 children, as against 45 in 300 adults, showing more than double the frequency of cerebellar tumors in children, and making about the same proportion as 179 cerebellar tumors out of 637 in Gowers's table.

The only tumors accessible to the surgeon, with the exception of a very few in the cerebellum, are those in the cortex and centrum ovale. Those in Starr's table number 234, of which 70 were inaccessible, and in the remaining 164 Starr estimates that there were 46 in which operation was clearly indicated and 37 in which it would probably have been successful. This gives about 6 per cent. Hale White estimates that 10 per cent. of 100 tumors in the museum of Guy's Hospital might have been successfully attacked. Knapp estimates that only 7 per cent. of 485 cases tabulated by Bernhardt could have been removed. Mills and Lloyd give 10 cases out of 100, and Dana 5 out of 29. Adding these together we have 1354 tumors, with only 98 that could probably have been removed, a little over 7 per cent.

One very important consideration in determining whether brain tumors can be removed or not is the character of the growth as to infiltration. A tumor definitely limited by a distinct wall, as in a well-defined cyst, or in which the delimitation of the tumor is definite, as in a fibroma or osteoma, may be thoroughly and completely removed. But to some extent the tubercular, and still more the malignant, growths infiltrate the surrounding tissues without any well-defined margins. In these cases it is evident that a considerable portion of brain tissue beyond the apparent limits of the tumor must be removed if we hope for success; and unless this be done it is useless to touch them. The same rule which leads the surgeon, in a breast case, to remove all the tissues infiltrated by a carcinoma, and also the lymph-glands, should lead him also to the wide excision of a malignant growth within the brain. Unfortunately this may destroy or maim various cerebral centres, but it must be done or the operation is useless.

SYMPTOMS OF BRAIN TUMORS.—The symptoms of brain tumors are now comparatively well known, and it is not too much to expect that

with increased familiarity with these symptoms, in the profession, there will come an earlier diagnosis, and therefore earlier and more successful treatment than has hitherto been possible.

(1) First, one of the most distressing symptoms of tumor is *headache*. This begins early, remits but little, and as a rule is excessively severe, especially in cerebellar cases, under the tense tentorium. If it occur in those cases in which removal of the tumor is impossible, the mere relief of the headache will warrant operation. Thus Horsley[1] records one case in which he removed nearly one-half of the occipital bone for an intracranial tumor which was irremovable, and the relief was so great that when from the growth of the tumor there was recurrence of the headache, the patient sought him and was glad to receive relief anew by the removal of the other half of the same bone. Macewen also testifies to the relief of the headache, vomiting, and even the paralysis (including region of control of the sphincter) which follows such a palliative operation. My own experience in two cases of irremovable tumor is also decidedly in the same direction. Unfortunately the location of the headache is not a guide to the site of the disease unless the tumor possibly is superficial. As a rule it is diffused rather than localized. In a few cases it is absent.

(2) *Pain* is almost always present, either as spontaneous pain or produced by pressure or percussion. The last form, pain produced by percussion, is probably more valuable than pain upon pressure as a localizing symptom, spontaneous pain being the least valuable of all.

(3) *Vertigo* is common, and is more marked in cerebellar tumors than in cerebral. In the former case also vertigo is often present in the recumbent as well as in the erect posture.

(4) *Vomiting* is often noted, and is of much value as a diagnostic point, if it be "cerebral vomiting," that is, if it have no relation either to the ingestion of food or evidences of disturbed digestion, such as furred tongue, constipation, diarrhœa, etc. It is often a most distressing symptom.

(5) *Epileptic Convulsions.*—These usually arise as soon as the tumor is large enough to produce pressure on the cortex. If the tumor is small and in the motor area, the convulsions may also be limited to the face, arm, or leg, and if so they are of the greatest value in determining the location of the tumor. If the attack always begins, for instance, in the same arm or leg, or in the same part of the face, the localizing value is very great. Unfortunately, however, such convulsions are apt to be general rather than local.

(6) *Choked Disc.*—This is almost always present in tumor, and arises as soon as the tumor has attained any size, though Seguin doubts[2] the frequency of this symptom. Unfortunately it gives little if any indication as to the position or character of the growth. If it exist in one eye the tumor is most likely to be in the opposite hemisphere; or if double, the lesion is most likely on the side of the least swelling. These indications, however, are only helps.

Given then headache, pain, vertigo, cerebral vomiting, epileptic convulsions, and choked disc, all or nearly all of these, and the diagnosis of an intracranial growth is almost certain. Possibly also by some of them, especially by localized epileptic convulsions, the location may be

[1] Brit. Med. Journal, Dec. 6, 1890. [2] Boston Med. and Surg. Journal, Feb. 5, 1891.

ascertained with some accuracy. But there are other symptoms which enable us to locate such tumors with much additional precision.

Thus there are other *eye symptoms* besides choked disc which help us. *Paresis, paralysis*, or *spasm* of any single muscle or group of muscles of the eyeball generally indicates either pressure from a coarse lesion in that portion on the cortex supplying the muscle, or infiltration of pathogenic material into the nerves themselves. Spasm is of more localizing value than either paresis or paralysis. *Hemianopsia* is of very great value, since it indicates a lesion of the cuneus on the same side. Thus if the right cuneus is involved, the right half of each retina will be blind, that is, the left half of each visual field will not be seen. The pupil also is apt to be dilated on the side of the tumor, but this is of no value in distinguishing between tumor and any other intracranial disease.

Motor aphasia indicates that the tumor is located in the third frontal convolution, on the left side in a right-handed person and on the right side in a left-handed person. (See also *Agraphia*, below.)

Paresis or Paralysis.—If the tumor is so located that it produces pressure on the centre for the face, arm, or leg, there may be paresis or paralysis of the face, arm, or leg of the opposite side; and if the tumor be large, a partial or complete hemiplegia may exist. The value of the late appearance of such local paralysis or paresis is again mentioned in regard to tumors of the frontal region.

Anæsthesia is rare, excepting when the internal capsule is involved, and may even then be absent. If the tumor presses upon the olfactory or any other nerve, or involves the nucleus of any nerve, it will first produce irritation, and afterward destruction of the function of such nerve.

Mental Symptoms.—As the tumor increases in size, stupor, deepening into coma, precedes death. At an earlier period in the disease, however, there are apt to be such mental disturbances as hallucinations and delusions, sometimes amounting even to delusional insanity; and there are especially apt to be a general loss of mental acuteness and of memory, and more or less childishness. The surgeon must, however, be on his guard as to the possible difficulty of distinguishing between hysteria and the symptoms of tumor.

Word-deafness, sensory or amnesic aphasia, is the loss of memory of the sound of a word. A spoken word conveys no meaning to the patient, though he may be able to recognize it when written. This symptom indicates a lesion in the posterior half of the first temporal convolution on the left side.

Word-blindness, or *alexia*, is the loss of memory of the appearance of a written or printed word. For instance, a word which would be understood when spoken is wholly unintelligible in writing or in print. This symptom is usually indicative of disease of the lower posterior portion of the parietal lobe on the left side, especially about the angular or supra-marginal gyri.

Agraphia is the loss of memory of the muscular movements necessary for writing; so that the patient, though able to move his arm perfectly well, will have lost the faculty of writing. It is apt to be associated with motor aphasia, and usually indicates a lesion beneath the motor speech centre or Broca's convolution, or possibly one of the posterior part of the second frontal convolution.

Apraxia is a general term denoting the loss of perception of the use, odor, color, taste, or other properties of any object. It has of course as many varieties as there are avenues by which the mind may be reached; for instance, sight, touch, smell, taste, hearing for language, hearing for music, etc., any of which may be lost, producing mind blindness, mind deafness, etc. An object which cannot be recognized by sight (mind blindness) may be very well recognized by touch. This symptom usually indicates a lesion also in the supra-marginal or angular gyrus in the left hemisphere in right-handed persons. One of the most remarkable instances of diagnosis based upon this symptom is related by Macewen.[1]

DIAGNOSIS OF BRAIN TUMORS.—It is a lamentable fact that at present our diagnosis, sometimes of the existence, but more often of the location, of a brain tumor, is far from being as exact as we could wish. Chipault[2] has tabulated 114 operations for brain tumor, in 47 of which the tumor was not found, either because it did not exist, or, much more frequently, because it was not rightly localized and was only discovered after death. More than one-third of the operations, therefore, have followed an erroneous diagnosis. The only consolation that surgeons can have in such cases is that the subject is so comparatively recent that our means of diagnosis are as yet very imperfect, and that all of these patients would have died just the same without an operation, though at a somewhat later period.

The evidences of the existence of a tumor have already been given, and the differential diagnosis, especially between tumor and abscess, has been dealt with on page 588.

Bright's disease and sometimes lead-poisoning resemble brain tumor in some of their symptoms, such as headache, vomiting, convulsions, and choked disc. But the examination of the urine and the œdema or dropsy of Bright's disease, and the wrist-drop and condition of the gums in lead-poisoning, enable us to make the distinction.

The means of locating a tumor have been already alluded to in general terms, but it must be remembered that a brain tumor may exist, even for a long time, without any symptoms whatever, or still oftener without any localizing symptoms of value. This is particularly true in what are called the latent zones of the brain, especially the anterior portion of the frontal lobes, the temporo-sphenoidal lobe, except a part of the left side, a considerable part of the parietal and occipital lobes, and to some extent the cerebellum.

Tumors of the motor area may be located by the means already described; tumors of the cuneus by the hemianopsia and other symptoms.

Tumors involving the second temporo-sphenoidal convolution and the angular and supra-marginal gyri have also been alluded to. It is of some importance, however, to allude especially to tumors of the frontal lobe and tumors of the cerebellum.

Tumors of the Frontal Lobe.—These are characterized first of all by early slowness of the mental processes. The comprehension is good and the conclusions are correct, if the patient is allowed time to think. But rapid mental action is impossible, and if insisted on results in confusion. There is also listlessness of manner, drowsiness in the

[1] Brit. Med. Journal. [2] Études de Chir. Médullaire.

day-time, and inability to hold the attention to any subject for any length of time. These conditions Starr[1] has shown to be present in one-half of the 23 cases which he has studied.

In addition to this, the ordinary symptoms of brain tumor will be present, and as the tumor grows in size, while the mental dulness may gradually become more marked, there will be after a time, from the remote pressure, a slight paresis of the muscles supplied by that part of the motor area which receives the pressure, and this will gradually deepen into paralysis as the tumor becomes larger. This late and increasing paresis and paralsyis following such slowing of the intellectual powers, is of great value as indicating tumor of the frontal lobe and its steady growth. Loss of smell from pressure on the olfactory bulb or nerve, and without nasal obstruction to account for it, is also of much value. Each nostril should be tested separately, as only one nerve or bulb may be compressed.

Tumors of the Cerebellum.—The general symptoms of brain tumor are not only present, but are apt to be developed with more than usual rapidity. The reason for this is thought to be that as the tumor is situated beneath the tightly stretched tentorium cerebelli, the pressure is greater and is exerted directly upon the veins of Galen and the *iter e tertio ad quartum ventriculum.* This is followed by an internal hydrocephalus, with rapidly developed choked disc and blindness. The headache is especially severe, and sometimes is almost the only symptom complained of. It may be general, sometimes even frontal, but occasionally is occipital. Tenderness to percussion over the occiput is however, a valuable sign. The knee-jerks are usually diminished in cerebellar tumor, but are exaggerated in tumors of the pons (Jacobi).

The most valuable symptom, however, of cerebellar tumor is the cerebellar vertigo or staggering. This is apt to be markedly and persistently toward one side. This symptom indicates pressure on the middle lobe of the cerebellum, or its direct involvement by the tumor. If it occurs early in the disease, the tumor is probably situated in the middle lobe; if later, it is the result of pressure upon or an extension into the middle lobe. In an analysis of 20 cases of unilateral staggering, Starr has noted that in 16 cases the patient staggered toward the side opposite to the lesion, and in 4 cases toward the same side as the lesion. There is also not uncommonly a tendency to fall backward.

If the symptoms already given do not enable us to decide on which side of the cerebellum the tumor is, we should note the effects on the cranial nerves, such as strabismus, facial or lingual anæsthesia, advance or retraction of the head. These usually bear first on the side of the tumor which crowds its side of the cerebellum down upon the base of the brain, thus pressing on the nerves, or pushes the cerebellum to one side and stretches them.

Paralysis of one fourth nerve, though difficult to detect, is of especial value, as it always occurs on the same side as the tumor (Starr).

Whether the tumor is cortical or subcortical is at present exceedingly difficult to diagnosticate. Possibly tenderness to pressure or percussion over the area of the tumor, a local rise of temperature, and the absence of anæsthesia may indicate its position.

Whether the tumor is multiple or single is also somewhat difficult

[1] Amer. Journal Med. Sciences, April, 1884.

to determine, but this can be done occasionally. Of course multiplo tumors should not be submitted to operation. If the tumor be single, the localizing symptoms should be referable to one centre only, if the tumor be small; or to several centres which are immediately adjacent if it be large. If, however, the centres involved are multiple and far apart, the probabilities would be in favor of multiple tumor or else of a very large single tumor. In one of my cases[1] the symptoms pointed to the involvement of several centres moderately far apart, but the post-mortem examination proved the growth to be one large tumor, which could not have been enucleated, although it literally dropped out of the brain during the removal of the cranial contents.

The size of the tumor can be occasionally diagnosticated by the means given in the last paragraph. In the presence of a large growth we would naturally be deterred somewhat from operating; but in view of the fatality of brain tumor and of the fact that we cannot tell whether a large tumor cannot be removed, and also of the recorded successful removal of very large tumors, we should not hesitate to make the attempt. At the worst, if the tumor is found to be irremovable, the operation may be terminated; and often with great advantage to the patient by the relief of pressure, as in Horsley's case of removal of the occipital bone already referred to. This I have had demonstrated also myself in two recent cases in which the patients' headaches and delusional insanity were entirely relieved, and their comfort greatly promoted, by the removal of the bone, the tumor being left.[2] Bramann has successfully removed the largest tumor on record, weighing nine ounces. Horsley has removed one of four ounces; and Weir and myself each one but little under four ounces. Of these four patients three recovered.

Prognosis of Brain Tumors.—Should no operation be done, brain tumor is practically a necessarily fatal disease. Though life may be prolonged for some time, the suffering is so great that death is a great relief. Almost the only exception to the fatality of brain tumors is in the case of those syphilitic growths which yield to the iodides. Hence we may say that unless the indications, such as multiplicity, position, size, etc., or the presence of other growths or of disease in other parts of the body, present positive contra-indications, an operation is justifiable.

The prognosis varies greatly in reference to immediate recovery and to ultimate recovery.

The fullest statistics are given in Chipault's book, in which the immediate results are given in 114 cases.[3] As already stated, in 47 of these no tumor was found, and of these 47, 35 ended in death and only 12 in recovery. In the 67 cases in which removal was accomplished 47 patients recovered and 20 died; a mortality of less than 30 per cent. This certainly is an extremely favorable showing for so new an operation. And there is no question that, as the profession is now alive to the possibility of the safe removal of cerebral tumors, many of them will come to the surgeon at a much earlier period than formerly, when

[1] Amer. Journal Med. Sciences, Jan., 1894.

[2] Annals of Surgery, Oct., 1892, p. 378.

[3] Dr. Mary Putnam Jacobi has given a table of 85 cases with fuller details in an excellent paper in the supplementary volume (ix.) of Buck's Reference Handbook of the Medical Sciences, p. 121.

they will be smaller and the complications fewer, and the mortality will with time greatly diminish.

The chief mortality lies in the cases in which no tumor is found, and in the irremovable cases. The reason for the fatality in these last two conditions, I believe, has been probably a too extensive exploration in search of the tumor or in an attempt to remove it. If therefore no tumor is found after a cautious search by the knife, the grooved director, and the gentle use of the little finger; or if, having been found, it is so large or deep that it is not removable, the operation should be terminated at once.

In this connection there is one indication which I believe to be of very great value, as indicative of the size of the tumor, viz., the amount of bulging. Sufficient attention has not, I think, been directed to this sign, especially as an indication to desist from further operative procedure. In one case[1] in which I recently operated the dura was so tense and resilient that I was certain that there was a very large tumor under it. Accordingly, instead of opening the dura widely, which would have allowed immense bulging and would have prevented the suturing of the membrane except after destruction of a very large amount of brain substance, I made an incision only an inch long. Through this I explored repeatedly in different directions, and, finding no tumor, closed the small opening. The pressure was such that even through this small opening a considerable amount of brain tissue protruded, and had to be removed in order to allow suturing. The patient recovered, was freed from his headache, and lived several months after the operation, in much greater comfort than before. Had I opened the dura widely I am sure that the patient would have died from the extensive traumatism which I should have been compelled to inflict upon the brain substance in order to close the wound, or from the subsequent fungus cerebri.

For a more favorable prognosis, it is of the utmost importance that the body of the profession, especially physicians, who almost uniformly are the first to see these cases, should recognize the symptoms of brain tumor, and the importance of calling in the surgeon at as early a date as possible. After the tumor has been diagnosticated and located, no period is too early for its removal. We should treat tumors of the brain precisely as we do those of the breast or any other part of the body. In fact, in the brain early operation is more imperative, since its soft tissues are more easily injured, they cannot escape from pressure as do other soft tissues not enclosed in a bony case, and the tumor grows insidiously, since its increase in size can only be estimated by the symptoms, and not, as in other tumors, by touch and sight. If therefore a brain tumor has been diagnosticated and located, and after three months, or often less, has not yielded to the iodide treatment carried to its limit, it is wasting time and imperilling life to wait further.

Tumors of the cerebellum are peculiarly dangerous. Starr has tabulated 16 cases which have been operated on; in 9 of these no tumor was found; in 2 a tumor was found but could not be removed. In 5 cases a tumor was removed, and of these five, three recovered. The reason for the fatality is obvious. Such tumors are close to the fourth ventricle, the tubercula quadrigemina, and the pons, in which

[1] Amer. Journal Med. Sciences, Jan., 1894.

are situated the most important and vital centres. Even, however, if not removable, great comfort can be given to the patient, as already stated, by the removal of the bone.

The *remote prognosis* is a very different matter. If the tumor be malignant, it will return as a rule in the brain, as elsewhere. If it be tubercular or syphilitic, the probabilities of a permanent cure are good; and if it be benign, recurrence is of course not probable.

It must be remembered that during the growth of the tumor, however, certain changes have been produced by it, just as a bullet in its pathway to its resting-place has inflicted a certain amount of permanent injury; and the removal of either bullet or tumor will not remedy the damage already done.

Hence, if optic neuritis has continued long enough to be followed by atrophy of the optic nerve, it is hopeless to expect that the blindness can be remedied; though I have seen it often improved, even after many years' duration of a tumor. So, too, the paralysis of an arm or leg is apt to lessen to some extent, but we must not expect it entirely to disappear. If the epileptic habit has been formed, the removal of the tumor will probably modify, and sometimes may even stop, the attacks.

TREATMENT OF BRAIN TUMORS.—The operative procedure in connection with the removal of brain tumors may be very briefly described, since the chief points have been alluded to in connection with the section on technique.

The median line and the fissure of Rolando are first to be located, and the upper and lower ends of the latter should be marked by puncturing the bone with a gimlet or small gouge. The centre of the presumed location of the tumor should be similarly marked. A large semilunar or horseshoe flap should then be made, with the position of the tumor as its centre. A large opening should then be effected in the skull, from one and a half to three inches in diameter, either by the trephine or the chisel. The dura should be opened, either to a large extent, if the pressure is not too great, or first to a small extent, to admit of exploration, and the opening enlarged later if deemed necessary (see caution on p. 611).

The tumor, having been found, may occasionally be enucleated by the finger; but if not, the knife, the scissors, the sharp spoon, or the handle of an ordinary teaspoon may be used to remove it, either in its entirety or piecemeal. If it be an infiltrating tumor, and therefore probably malignant, it is of the utmost importance that a considerable amount of apparently healthy brain tissue should be removed beyond its margins, so as to be certain that all the diseased tissue has been taken away. This may involve important cerebral centres; but a tumor is no respecter of persons or centres, and the surgeon must be ruthlessly thorough if he remove it at all.

If the tumor be subcortical, an incision should be made in the brain, and the tumor be sought for by the little finger, inserted with great gentleness, and also by the probe or grooved director, in order to recognize its size, depth, character, etc. If it be so large that it is not wise to attempt its removal, the operation should be immediately terminated, the dura sutured and the flap replaced, the bone not being restored. In some cases of large tumor only a portion of the tumor has been re-

moved, yet with great benefit to the patient. Sommer[1] even recommends that this be done piecemeal so as to avoid the danger of a sudden alteration of pressure. But we are not at the end of our resources when such a partial operation has been done. Second, and even third, operations have been done at the request of patients, and additional relief from the symptoms and prolongation of life have been given to them. Thus Czerny has operated twice in one case, and at the last report was contemplating a third operation. Bramann[2] has operated thrice, with improvement each time; and Reynier and others have done repeated operations on the same patients. In one unpublished case of a large angeiolithic sarcoma I have operated twice, and the patient has been greatly benefited. It is right also to call attention again to the wisdom of not doing too much at once in such cases. Experience has taught me great caution in dealing with large cerebral tumors.

Hemorrhage is to be dealt with as has been described under the head of technique, to which the reader is referred for the other ordinary steps of the operation.

Cerebral Cysts, Including Dermoids and Hydatids (Echinococci).

Cerebral cysts are of several varieties. The most common perhaps are simple serous cysts, resulting from old blood-clots, or in some cases apparently of spontaneous origin. Not uncommonly gunshot wounds or other penetrations of the brain by foreign bodies, or by fragments of bone from fractures, are followed by the development of either blood-cysts, or, at a later period, serous cysts. Sometimes old blood-clots are only partially absorbed, and instead of becoming cystic remain practically as foreign bodies. McBurney has removed such a clot with success after four months. Next frequently perhaps will be found blood-cysts, and occasionally in tumors, especially the gliomata, there will be cystic development in the interior. The symptoms of all such cysts are practically the same as those of tumors, modified of course by their individual causes, and they demand similar treatment.

Dermoid Cysts.—Turner,[3] Paget,[4] and Ogle[5] have described dermoid cysts in connection with the dura mater and pia mater. These find a ready embryological explanation in the fact that in early fœtal life the skin and the dura are in contact, the bone being a later interposition. A portion of the skin becoming involuted under the bone will develop into such a cyst.[6] Sometimes, however, such dermoids develop in the brain itself, probably from a deeper involution. Thus Kruse[7] has reported a case in which a dermoid cyst the size of a walnut was found in the fourth ventricle of a man who died of tubercle. It was filled with hair and pasty material, but strange to say had produced no symptoms of its presence. He also cites two other cases in the cerebellum[8] and in the right corpus striatum.[9] In the latter there were

[1] Lancet, 1893, vol. ii., p. 644. [2] Arch. für klin. Chirurgie, Bd. xlv., 1893, S. 365.
[3] St. Barth. Hosp. Reports, vol. ii., p. 62. [4] Lectures on Surgical Pathology.
[5] Brit. and Foreign Med. Chir. Rev., 1865. [6] Sutton, General Pathology, p. 169.
[7] Deutsche med. Wochenschr., 1891, S. 567.
[8] Irvine, Trans. Path. Soc. London, vol. xxx., 1879, p. 195.
[9] Bericht allgemein. Krankenh., Wien, 1867.

no symptoms. In Irvine's case the girl, aged seven, after a fall on the back two years before, had a gradually increasing paresis of the legs with impaired sensation, the cause of which was thought to be spinal. Double internal strabismus and convulsions followed, and she died conscious two months subsequently. Post-mortem inspection disclosed an abscess containing caseous material and hair, involving both lobes of the cerebellum and extending into the medulla. The ventricles were distended.

HYDATID CYSTS.—These are much commoner, especially in regions such as Australia and Germany, in which these parasites are not unfrequently seen. Thus Escher, of Trieste,[1] records the case of a child of eleven who suffered from epilepsy and other symptoms of tumor. By a syringe he established the diagnosis of hydatids, and removed a large cyst, occupying the greater part of the right frontal and parietal regions; but the patient died in a few hours. Verco[2] reports a case in a boy of eleven, with all the symptoms of tumor and a diagnosis of echinococcus. At the operation an enormous cyst was opened and drained. Death followed from meningitis. Castro[3] reports a case in which two cysts were found. The patient died from meningitis.

Chisholm,[4] by means of an aspirating needle and then a Southey's tube, evacuated about three ounces of the contents of a hydatid, drop by drop. Then by a small incision through a layer of brain susbtance only one-twelfth of an inch thick, a fine rubber tube was introduced, and he evacuated in half an hour nineteen and a half ounces of the contents in all. The cyst walls were so adherent that they could not be removed. The temperature rose to 106.2° F., and the patient died in twenty-three hours. Llobet[5] records the case of another child, aged thirteen, who suffered from hemiplegia and Jacksonian epilepsy, but whose general good condition led him to expect a hydatid cyst. He removed the cyst, which contained 26 grammes of fluid, without difficulty. Six months afterward, the headache, epilepsy, and hemiplegia had entirely disappeared, and, except for faulty memory and imperfect vision, the child was well. Another case of complete recovery is reported by Graham and Clubbe.[6] The cyst contained 19 ounces of fluid; the boy's sight, however, never returned. Davies Thomas[7] refers to 97 cases of cerebral hydatid out of 2000 cases in various parts of the body. Of these 97 cases, two[8] and possibly a third ended favorably. In America, Osler[9] has collected 61 cases, of which only two were in the brain.

The most important recent contribution to the surgery of echinococcus of the brain has been published by Mudd, of St. Louis.[10] The case was very naturally, from the symptoms detailed, supposed to be one of tumor, probably a sarcoma. The patient was operated on March 20, 1891. The collapsed cyst was removed, with many others of varying sizes. The lateral ventricle also was opened and drained; having been mistaken for an additional cyst. The escape of the ventricular fluid continued for seventeen days, without doing any harm. The excavation

[1] Lancet, June 27, 1891, p. 1444.
[2] Centralbl. f. Chir., 1890, S. 888.
[3] Jahrb. f. Kinderheilk., Bd. xx., Heft 1.
[4] Brit. Med. Journal, 1892, vol. ii., p. 1296.
[5] Rev. de Chir., Nov., 1892, p. 970.
[6] Australasian Med. Gazette, July, 1890, p. 243.
[7] Trans. Intercolonial Med. Congress, First Series.
[8] Davain, 1836, and Odile, 1884.
[9] Amer. Journal Med. Sciences, Oct., 1892.
[10] Ibid., April, 1892, p. 412.

left by removal of the cyst was as large as a hen's egg, and the cavity of the lateral ventricle was well exposed. The patient recovered entirely. This is the only case of operation reported in America. Of the seven patients operated on three have recovered.

The symptoms of hydatid cyst are usually of an intermittent character. The blindness is apt to develop quite suddenly; and if at first unilateral, is said always to be on the same side as the cyst.

The symptoms of all these various kinds of cyst, parasitic or otherwise, will as a rule be the same as those of tumor, though they are apt to be less pronounced, perhaps by reason of the fact that the cyst, being soft, does not exert so much pressure as a solid growth. In other respects the diagnosis between cystic tumors and solid tumors cannot, as a rule, be made prior to operation, except in the cases, excessively rare in this country and in Great Britain, of hydatid cyst. The treatment as a rule is by an exploratory operation and removal. If possible the cyst wall should always be extracted. If this is not possible the cyst should be drained.

Actinomycosis of the Brain.

As far as I know, there are only three cases of primary actinomycosis of the brain reported. The first one is recorded by Bollinger.[1] The patient was twenty-six years of age, and the symptoms were such that a diagnosis of tumor of the brain was made. The parasite formed a tumor in the third ventricle, and all the ventricles were considerably dilated. There was no tendency to suppuration of the tissues, as is so commonly found in cases of actinomycosis elsewhere. The presumption is that the parasite entered the body through the skin or mucous membrane without producing the disease at the entrance point, and reached the brain by embolism.

The second case is reported by Gamgee.[2] The man was 65 years old, and had suffered for several years with an abscess of obscure origin in the abdominal wall. When he first came under Dr. Gamgee's care he had an effusion in the left side of the chest, paralysis of the right arm and leg, with slight dilatation of the right pupil, and convulsions of the right arm; death soon followed. At the post-mortem examination, besides pus in the left pleural cavity, there was a large abscess of the liver, with many masses of the ray fungus. Three abscesses in the brain also contained the fungus.

Keller[3] has recorded, however, the first, and I believe up to this time the only case, in which actinomycosis of the brain has been diagnosticated during life and operated on. The patient was a married woman, 40 years old, who had suffered from a series of abscesses following pleurisy. Suspecting that they might be of actinomycotic origin, he examined the tissues by the microscope and found the ray fungus. Two years subsequently she was admitted to the hospital, with gradually increasing weakness of the left arm, and from the prior invasion it was deemed likely that there was a secondary growth of the fungus in the brain.

[1] Münch. med. Wochensch., 1887, No. 41.
[2] Brit. Med. Journal, 1889, vol. i., p. 1172.
[3] Ibid., 1890, vol. i., p. 709.

Afterward, epilepsy supervened, and the paralysis of the left arm became complete left hemiplegia, involving the face, with headache, vomiting, and entire loss of consciousness. She was in a comatose and apparently moribund condition. Her family finally consented to an operation. Two ounces of thin green pus, containing quantities of the fungus, were evacuated. By the next day she had regained her consciousness. In eight days the face had recovered and the leg had begun to recover, and she was able to walk in six weeks. There still remained, however, after some months, a weakness of the left arm and slight contraction of the fingers. Nearly a year afterward the paralysis began to increase again, the vomiting and convulsions returned. The old wound was reopened and a considerable quantity of pus removed, but she died in a few days. Post-mortem inspection showed a hernia cerebri occupying the middle third of the right frontal and parietal convolutions, and underneath, an unopened, encapsulated abscess, the size of a nutmeg. Very clearly, the diagnosis can rarely be made, but the earlier that operative interference can be had the better.

The cure of actinomycosis in cattle by the iodide of potassium has recently attracted attention. Dr. Salmon,[1] of the United States Bureau of Animal Industry, has stated that 63 per cent. of cattle so treated have recovered. This has suggested its use in man. Buzzi and Galli-Valerio[2] refer to a case reported by Van Iterson[3] and record another of their own, in which, after failure of operation to cure, the administration of 30 grains of the iodide, daily, effected a complete cure in three months. The method should undoubtedly be tested in every suspected case before resorting to operation. The improvement seems to begin quickly and to progress rapidly.

Surgical Treatment of Epilepsy.

Four varieties of epilepsy should be distinguished from each other surgically. (1) The first, and by far the commonest form is the *general or idiopathic epilepsy*, in which the fit is apt to begin with a cry, and the convulsions are general from the start. The pathology of this form is as yet unknown. (2) A variety of this form of epilepsy is what is called *focal epilepsy*, in which the fit, instead of being general from the outset, begins always or nearly always in one part, as, for instance, in the right leg or the right arm, and from that as a starting-point extends over the entire body. Sometimes slight pathological degenerative changes have been observed, but more frequently the brain appears entirely normal. (3) The third variety is *Jacksonian epilepsy*, named after its distinguished describer, Hughlings Jackson, of London. Nearly thirty years ago Dr. Jackson described this form of epilepsy, in which consciousness is not lost, and the attack, beginning in the face, will extend to the arm and then to the leg, or from the leg will pass to the arm and then to the face; or, beginning in the arm, may extend to the leg or face. It will be observed that this "march of the fit," as it has been called, corresponds with the topographical relation of the motor

[1] Med. Record, Jan. 21, 1893, p. 84.
[2] Brit. Med. Journal, Epitome, Aug. 5, 1893, p. 23.
[3] La Semaine Médicale, 21 Déc., 1892.

centres in the brain, the face centre lying at the lowest part, the arm centre above that, and the leg centre above that. If the fit begins in the face centre, it is apt also to involve the speech centre just in front of it, and so produce aphasia. (4) Another form, which may be distinguished surgically, but may cover any one of the three forms already described, is the so-called *traumatic epilepsy* in which the disease seems to be the direct result of an injury.

I. General or Idiopathic Epilepsy.—Since it has become popularly known that surgery can do something for epilepsy, an immense number of patients suffering from this form of the disease have applied for relief. But fortunately the good sense of the vast majority of surgeons has been proof against the importunities of these patients, and few operations have been done in such cases. No possible benefit can be expected in this form of the disease. There is no guide as to where the surgeon should trephine, or what he should do, should he go so far as to open the skull. Unfortunately this class of patients form the vast majority of all epileptics, and they are at present beyond surgical aid.

II. Focal Epilepsy.—In these cases the first thing necessary for the surgeon is to make sure of the statements of either the patient, or more often of his friends, that the epilepsy is really of this type. It has occurred to me in many cases to have a history of an apparently distinct focal epilepsy given; but when I have placed the patient in hospital under the observation of a trained nurse, whose only business was to watch the patient, observe, and immediately write down a description of the fit, I have found that the statements were entirely erroneous. Hence I regard it as a matter of imperative duty that no history, however apparently exact and consistent, should be accepted without such observation. And this observation should be not only of one or two attacks, but of a sufficient number, say half a dozen or more, to verify or disprove their asserted local and uniform beginning. Moreover, as Putnam has pointed out, the value of spasm starting in highly specialized parts, such as the fingers, whose equilibrium is easily disturbed, is much less than that of spasm starting in the coarser, better balanced muscles of larger joints, such as the shoulder.

The operative treatment of focal epilepsy has been the exposure of the centre in which the fit begins, its recognition by means of the faradic battery, and its excision.

It must be confessed that the results from published cases have not been such as to give very great encouragement to continuance of this mode of practice; but, on the other hand, sufficient time has not yet elapsed to enable us to speak with certitude on the subject. Any operation—an amputation, or the excision of a tumor—will often arrest epilepsy, focal or otherwise, for a considerable time; and we must remember, therefore, that the occasional improvement sometimes induced may be the general result of the operation, and not of excision of the brain centre. Moreover, it has been argued, with some show of reason, that the excision of such a centre must necessarily be repaired by means of a scar; and it has been amply proved in many cases of traumatic epilepsy that such a scar may itself be apparently the source of irritation which brings on epilepsy.

This, however, is to be said in extenuation of the operation, that an aseptic excision, followed by immediate primary union, leaves a scar much less likely to cause irritation than the coarse, irregular, branching cicatrix which follows an infected trauma. Moreover, in not a few cases, the excision of a traumatic scar, and the substitution for it of the simple scar of an aseptic operation, has been followed by amelioration and, in some cases, by cure. The whole question, as yet, is under consideration, with a tendency, upon the part of surgeons, I think, toward less interference rather than more.

The percentage of deaths is not large, perhaps from five to seven per cent., in these cases; and therefore it is reasonable to take the risk of an operation in so dreadful a disease. There is no probability that the patient will be made worse. It is of great importance, in these cases, to make a large opening in the skull, best by the Wagner-Wolff method (see Technique), which allows of a much larger opening than the use of the trephine. This will enable us to recognize the convolutions, and by the battery to ascertain the exact location and limits of the desired cerebral centre.

It is possible that one of the reasons for the failure in many cases of operation for both this and the other forms of epilepsy which are suitable for interference, has been timidity as to removal of considerable portions of brain tissue. On the one hand, it is true that a wide removal will result in extensive paralysis of the parts supplied. But I have never yet seen this paralysis permanent. Either the opposite side takes up the work after a time, just as we learn to write with the left hand when we lose the right; or, as seems more probable, the area of brain cortex which supplies an extremity, or a part of it, as, for instance, the hand, the shoulder, or the face, overlaps and extends into neighboring brain centres, and the less used peripheral portion of the centre awakes to activity when the central portion is removed. It is to be remembered, especially, that removal of cerebral centres can be much more safely done in the antero-posterior direction than in the vertical; because if we go above or below the immediate centre involved, we are certain to remove parts of other and adjacent centres, and hence to produce a more widespread paralysis.

In removing any portion of the cortex, one of the chief dangers is hemorrhage. The large veins in our way should therefore either be first tied, or, not uncommonly, the pia and its vessels can be stripped off from the underlying convolutions, and thus the vessels be avoided. The centre to be removed should be outline by the knife held vertically to the surface, and all of the gray matter should be removed down to the white substance.

The *after-treatment* of these cases is that which is described in the section on technique. In all cases, however, the medicinal and dietetic after-treatment, especially by the bromides, should also be carefully and persistently carried out if we wish to obtain the best results.

III. Jacksonian Epilepsy.—While more commonly non-traumatic, yet this sometimes follows injury.

A few cases are reported in which momentary faradization of the cortical centres which are evidently diseased has produced a fit entirely analogous to those from which the patient has suffered. In a

healthy brain, such momentary faradization produces only a single movement of the part supplied by that portion of the cortex. I have suggested that the production of such a typical fit by momentary faradization might be of value in determining whether a cortical centre which was apparently healthy was really diseased; but I do not know of any observations which bear upon this suggestion.

In an asserted Jacksonian epilepsy, the same precautions to ascertain the truth or falsity of the statement must be insisted on as in focal epilepsy. Fortunately, in cases of Jacksonian epilepsy, the patient himself, if he is a careful observer, can aid us very much, since consciousness is not lost. In both this form of epilepsy and in focal epilepsy, also, the dynamometer may be of use to us. As soon after the attack as the patient can use the instrument, the grasp of the epileptic hand and of the opposite healthy hand should be compared; the severe spasms exhaust the muscular power of the part involved in the fit; and the registration of the dynamometer should be less on the affected than on the healthy side.

Charcot[1] and Tourette[2] have pointed out also a means of distinguishing between the effect of partial epilepsy of the genuine type and a hystero-epilepsy, in examination of the urine. The latter author states that, in true epilepsy, there is a decided augmentation, at the moment of the fit, of the fixed residues, specially of the urea and the phosphates; and in hystero-epilepsy a sensible diminution of these. Charcot states that normally the proportion of alkaline phosphates to earthy phosphates is about three to one, and that this proportion is little altered after a fit of genuine epilepsy; although the total amount of urine, of urea, and of both phosphates increases. After an attack of hystero-epilepsy, the earthy phosphates increase to two-thirds of the alkaline phosphates, or even to an equal amount, with a decrease, however, of the total amount of both urea and the phosphates.

The surgical treatment of well-marked Jacksonian epilepsy is the same as for focal epilepsy, viz., the early excision of the cerebral centre involved, before the epileptic habit has been formed. The prospects of benefit or of cure are better than in focal epilepsy, especially if the Jacksonian epilepsy has followed an injury. Though not a few cases, especially those in which the operation was done long after the epilepsy began, have not been benefited, yet so large a number have been benefited or cured as to make a resort to operation justifiable. The possibility of failure, however, should always be explained to the family and patient. The after-treatment by drugs should also be invariably pursued.

IV. Traumatic Epilepsy.—While in a few cases the epileptic attacks begin within a few weeks of the reception of the injury, as a rule their appearance is delayed for some months or even years. At first the attacks are apt to be infrequent, and are often attended by only a momentary loss of consciousness (*petit mal*); but afterward become typical epileptic attacks (*grand mal*). Even slight accidents, in some cases, are followed by epilepsy, probably by reason of a cicatrix in the dura or in the brain. Compound and especially depressed fractures in very many cases irritate the underlying cortex and are followed by epilepsy.

[1] Progrès Méd., 15 Novembre, 1890, p. 393. [2] Rev. de Chirurgie, 1892, p. 413.

Hence in all cases of compound fracture with depression, the profession is coming to recognize the importance of immediate elevation of the bone; and if the brain tissue has been lacerated, it is probably best to excise the injured portion.

The severity of the disease is sometimes remarkable. Thus in one of Horsley's cases, after an old depressed fracture of the skull, the patient had 2870 convulsions in 13 days.[1] And in Miles's case,[2] in which the patient had been struck on the top of his head by a lead sinker, weighing about a pound, he had as many as 3597 fits in 42 days, and as many as 219 in a single day. Yet both of these cases were cured by operation.

If the epilepsy arises from trauma, the seat of injury probably is over well-known centres, motor or otherwise; but, on the other hand, it may lie over the so-called latent zones of the brain.

In those cases in which the lesion lies over well-known centres, and the muscles involved in the epileptic fit correspond to those innervated by these centres, the natural inference is that the lesion and fit are related as cause and effect. But it must be strongly insisted on that the site of operation should be determined rather by the localizing symptoms than by the external scar, because the actual lesion may have been caused by a splinter of the bone or by injury of the brain by other means, at some distance from the seat of the injury and not directly under it.

Moreover, excision of the scar itself, if one exists, has occasionally been followed by a cure, and in one unreported case of my own this seems to have been permanent. It would be right, therefore, as a preliminary minor operation, to first excise the scar. And also, if there be any other disease, such as necrosis of the tibia, this should be remedied first; in a case related by Briggs, the removal of necrosed bone was followed by a cure, which had persisted for five years when the case was reported.

The injury may have been followed by splintering of the bone, by the formation of a clot, which is very apt to be followed by a cyst, by a brain scar, by adhesion between the brain and its membrane, or sometimes by no apparent lesion. In the remarkable case of Mr. Miles just quoted there was no apparent lesion of the brain; and yet simple trephining had cured his patient three years and a quarter before the case was published.

After opening the skull, the dura, in these cases, should always be incised. Should a scar exist in the dura, it must be removed. Should one exist in the brain, this must be removed down to the white substance, and as much further as the scar goes. All of the damaged brain tissue must be removed. If any of the dura has been sacrificed, its place may be supplied by a piece of the pericranium, as described under technique. This is especially important in those cases in which the brain has been incised, in order that we may prevent a fungus cerebri. In other respects the treatment is that described in the section on technique. Of course if the bone is diseased, or is irregular and would produce irritation or pressure, it should not be replaced after removal.

In those cases in which the lesion does not lie over well-known centres of motion or of special sense, but over latent zones, if excision of the scar does not effect a cure and there is distinct evidence of either

[1] Brit. Med. Journal, 1887, vol. i., p. 864. [2] Lancet, 1891, vol. ii., p. 1159.

fracture or irregularity of the bone, the skull should be opened and the dura also incised, further procedures being regulated by what is found.

Any dural scar, brain scar, or diseased brain tissue or cyst should be treated by excision. If adhesions have formed, the proposition of Beach[1] to insert a piece of aseptic gold-foil between the brain and the dura may be adopted, as has been successfully done by Park. If there has been a prior trephining, at the time of the injury, removal of the thickened edges of the opening and of scar tissue, and possibly the insertion of gold-foil, will often be followed by great improvement, and in some cases will even effect a cure. Any such operation to be effective, however, must be thorough.

The degeneration of the ganglion cells and the hyperplasia of the connective tissue have been shown by Van Gieson to be slow processes; and Sachs has especially insisted on the wide secondary sclerosis in the brain and the epileptic habit following it. Both of these observations render early rather than late operations imperative, if we would really cure our patients.

Conclusions.—Perhaps the most difficult of all the diseases with which modern cerebral surgery has interfered, in which to give a fair and reasonable judgment, is epilepsy. The following, however, after considerable experience, seem to me to be just conclusions:—

By far the vast majority of cases of epilepsy are wholly unsuited for operation, including in this class all those of general epilepsy and a very large number of other cases. In Jacksonian and in focal epilepsy, especially in the former, a considerable number of cases will probably be cured, a not inconsiderable number will be much benefited, and the remainder will be made neither better nor worse. In traumatic epilepsy a larger number will be cured, a larger number benefited than in the last two classes, leaving of course a smaller number unaffected by the operation.

In all classes, it can be said that the danger is moderate, provided that the operation be absolutely aseptic in its technique. If simple trephining is done, the risk is very slight. If the brain be involved in the operation, then the danger will be increased in proportion to the degree of interference; but the mortality will rarely exceed ten per cent. even then, and will usually be less.

TREPHINING FOR HEADACHE.

Occasionally, headache is of itself a serious ailment. When persistent, severe, and unconquerable, it may disable a man entirely from work, and be so serious an impediment to earning a living as to warrant interference. Horsley has advocated trephining for the relief of this condition, and has reported cases in which he has done the operation with excellent results. Warren[2] has reported an excellent case in point. Weir has trephined in one traumatic case, in which the headache was the only symptom. Relapse followed temporary relief. I

[1] Boston Med. and Surg. Journal, April 3, 1890.
[2] Annals of Surgery, Sept., 1893, p. 259.

have operated in two cases. In the first, following trauma, the patient recovered entirely and was able to resume his occupation; but in the second case the operation failed entirely. From later developments I am inclined to believe the latter patient to have been neurasthenic. Nothing was done in any of these cases except simple trephining, which is better than using the chisel. The result apparently is due to a change in, or relief of, the intracranial pressure. At least, that is the only rational explanation which occurs to me in connection with the procedure.

Hoffmann[1] has reported three cases of excessively severe headache, complicated, however, with other symptoms, such as paresis of various muscles, and in one case difficulty of speech; apoplexy with loss of consciousness for four days, severe headache, tottering gait, and suicidal impulses, in the second; and in the third, severe headache, vomiting, slow pulse, epilepsy, and hemiplegia. In the first two cases there was evidence of former ear disease on the same side. In all of them Hoffmann trephined the mastoid, exposed the lateral sinus, and opened it. Nothing was found except sclerosed bone and thickened dura, and very dark blood in the sinus. Recovery followed in all. It is evident of course that more than mere headache was present in these cases; but as they are obscure in their origin, and as the headache was the most prominent disabling symptom in all three, they find their place here better than elsewhere.

The relief of the intense headache from tumor of the brain by trephining has already been alluded to.

Trephining for Athetosis.

This is a disease of the nervous system, characterized by irregular tremors or movements of the arms and legs; or sometimes, as in a case at present under my care, limited to a single member, as the arm. It is very often a result of the cerebral palsy of children, and is sometimes accompanied by epilepsy, and occasionally by contractures. In other respects the patient may be in good health and mentally sound.

The advisability of operating in these cases is as yet doubtful. Mr. Horsley[2] regards athetosis as a form of cortical discharge, and has reported one case in which he operated without benefit. The patient's movements began as a rule in the thumb, and hence he removed the thumb centre. In a fortnight, as the surrounding cortex resumed its activity, the spasms returned. He urges the removal of the entire area innervating the part involved (if, I suppose, the disease be limited to a single extremity; he would scarcely propose to remove both an arm and leg centre, producing an entire hemiplegia). Oppenheim[3] records another somewhat more hopeful case, in a child of 12 who had had the cerebral palsy of childhood, and epilepsy beginning at 4 years of age. This was followed by right hemiplegia and contracture, the athetosis setting in subsequently. At the operation a cyst was found, and the final result was that the athetosis and contracture were both improved, while the epilepsy, although continuing, was less frequent

[1] Centralbl. f. Chir., 1889, No. 29. [2] Brit. Med. Journal, 1890, vol. ii., p. 1291.
[3] Deutsch. med. Wochenschr., 3 Juli, 1890, S. 595.

and less severe. In a case under my own care, in which the athetosis is limited to the left arm, and in which the cause has probably been a small hemorrhage into the internal capsule, catching the fibres from the corpora quadrigemina and producing an irregular hemianopsia, I have not thus far thought it right to operate on the brain. The patient is an adult and still finds the arm somewhat useful. I stretched the brachial plexus above the clavicle, but the operation was not followed by any improvement. When the disease arises in childhood, especially in connection with the cerebral palsies of children, I should certainly advise against operation, with our present knowledge. It is, however, but just to say that our experience is as yet too limited for us to be dogmatic.

TREPHINING FOR ARRESTED DEVELOPMENT.

Sometimes a case of arrested development is distinctly traumatic in origin. For these cases there is some hope of relief, but where the condition arises as a congenital defect it is very doubtful whether operation should be attempted. Dr. Felkin and Mr. Hare[1] report the case of a girl of 17 who had had her skull fractured at the age of 10 months, followed by paralysis and imperfect development of the right arm and leg. At the operation a cyst was found, two inches in depth, with an osteophyte half an inch long. The lesion being extra-dural, the membrane was not opened. Marked improvement followed the operation. I have operated, much against my will, in a case of arrested development[2] in which I found great atrophy of the central portion of the left hemisphere. The patient died immediately after the operation. I had at first refused to interfere, but afterward unwisely yielded to the importunities of the parents. Certainly no operation whatever could have done this child, or any other similarly affected, any good. The cause of the atrophy was a thrombus, or possibly an embolus, in the middle cerebral artery, and all the area supplied by this artery was wasted.

TREPHINING FOR CONGENITAL CEREBRAL PALSIES.

Two of the best recent non-surgical papers on the cerebral palsies of childhood are by Osler[3] and by M. Allen Starr.[4] The conclusions reached by both these authors are on the whole against operation, although Osler records a case operated on by Morton in which some improvement followed, and Starr gives a qualified approval to occasional interference. In a few cases, especially those in which hemorrhage is the cause, an immediate operation might be of value; but in 343 cases Starr has only reported 18 of this character. The great majority, 239 cases, were due to porencephalus and sclerotic atrophy, in not a few of a very extensive character. The difficulties surrounding diagnosis are such that it is almost impossible in any given case to say just what the condition is. But as such chronic cases are incurable by medicine; as it is impossible without an exploratory operation to deter-

[1] Manchester Med. Chron., Oct., 1891, p. 17.
[2] Amer. Journal Med. Sciences, Sept., 1891, p. 235.
[3] Med. News, 1888, vol. xxxiii., p. 29 *et seq.* [4] Med. Record, Jan. 23, 1892, p. 85.

mine absolutely what pathological condition exists; as the danger of operation, especially if it be conducted with great care not to go too far and to be as speedy as possible, is not very great; and as death itself is in most of these cases a boon, an operation may occasionally be proper. But the cases must be carefully selected, and should be limited to favorable examples among those most likely to have been caused by clots, cysts, or tumors. When the brain is manifestly atrophied, as shown by a marked difference in the development of the two sides of the skull, I should advise against any operation.

Linear Craniotomy for Microcephalus.

In this disease the entire head is lacking in development. It may even be excessively small. There is sometimes a difficulty in determining precisely the amount of the defect. The following table from Finlayson's article[1] may be of value:—

No. of Cases.	Age.	Head. Inches.	Chest. Inches.	Difference between Head and Chest.
100	One day	13.75	12.94	Head more than chest, 0.81
66	6 to 12 weeks	15.25	14.25	" " " " 1.00
75	6 to 8 months	16.68	15.58	" " " " 1.10
71	11 to 13 months	17.80	17.20	" " " " 0.60
67	21 to 24 months	18.38	17.85	" " " " 0.53
50	34 to 36 months	18.70	18.61	" " " " 0.09
60	4 to 4½ years	19.20	19.72	Chest more than head, 0.52
46	6 to 6½ years	19.51	20.76	" " " " 1.25
40	9 to 10 years	19.56	21.31	" " " " 1.75
31	11 to 12 years	20.00	23.46	" " " " 3.46

The pathology of this affection is very doubtful. Unquestionably, as a rule, the growth of the encasing hard parts is dominated by the growth of the contained soft parts, and the relative growth of the brain and skull is a resultant of the reciprocal pressure, centrifugal and centripetal, which each exerts upon the other. In normal cases, in which ossification of the sutures takes place at the usual time, the skull yields before the growing brain; but it is very possible in a brain of feeble development, lacking the power of growth, that if early ossification of the sutures should take place, this slight added resistance might overcome and check the power of expansion and growth possessed by the brain. Sometimes this ossification of the sutures is noticed even at birth, and in most cases of microcephalus, at an early period after birth. It is undoubtedly true, however, that some cases of microcephalus do not show any evidence of such premature ossification. It is very probable that in these cases the rate of growth both of the skull and of the brain is lessened.

In microcephalus, accordingly, Lannelongue[2] proposed to make by resection a groove in the skull about a quarter of an inch wide, in order to allow of more rapid expansion and growth of the brain. This groove is more commonly made on one or both sides of the sagittal suture, extending from low down on the forehead into the occipital bone. It

[1] Keating's Encyclopædia of Diseases of Children, vol. i., p. 91, foot-note.
[2] L'Union Méd., 8 Juillet, 1890.

may have one or more lateral branches. Where the faulty development is chiefly in the frontal region, it would be best, as in one of Park's cases, to make a groove transversely and a little in front of the biauricular line. The dura at the superior longitudinal sinus can with care be loosened from the bone without rupturing the walls of the sinus. Soon after the publication of Lannelongue's first case I reported the first operated on in America.[1] Since then a large number of other cases have been recorded, by Wyeth,[2] Broca,[3] Park,[4] Lannelongue,[5] myself,[6] and others. The results have been very various. The mortality is large, averaging, even with Lannelongue's favorable report, about 20 to 25 per cent. This would naturally be expected, inasmuch as these children are almost always feebly developed, and while the loss of blood is as a rule moderate, yet the shock of so extensive an operation must be very great. For this reason it is never advisable to operate on both sides at once. An interval of from two to four weeks should intervene between the successive operations. Hence also the danger should be very fully explained to the parents, as otherwise they may justly blame the surgeon. The limits of age I should place at about 9 months for the mininum, as under that age the child would be too feeble, and about 8 or 9 years for the maximum; Park,[7] however, has reported one of his best results in a boy 9 years of age, and older patients have been operated on.

As to the effect on the mental development, the majority of the patients who recover from the operation show no improvement. Quite a number show a moderate degree of improvement, while in a few instances this has been very gratifying indeed. In one of my own cases, in which the mental state of the child has been comparatively little improved, the operation has been of the greatest value to the mother, inasmuch as before the operation the child demanded constant care, both day and night. Since the operation the mother is relieved very much during the day, and at night obtains a sound sleep instead of being wakened repeatedly at very short intervals. This to a working-woman with other children to care for is very important. As a general conclusion, therefore, my own judgment is that the operation is at present justifiable, in cases of decided microcephalus. In cases of simple idiocy without microcephalus, I should unquestionably be unwilling to perform an operation. I have refused a large number of cases, in some few of which I have had reason to believe that the parents sought it with a view to being relieved of the care of the child by death.

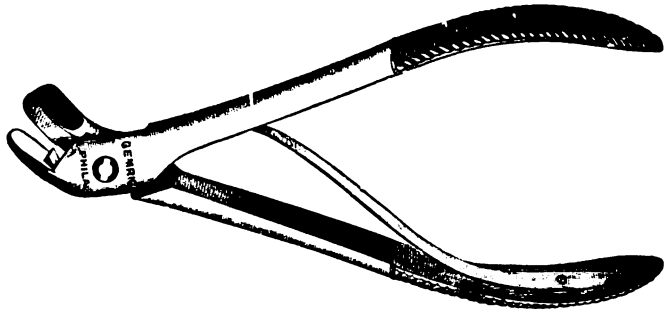
In one of my cases, in which, at the Infirmary for Nervous Diseases, a year previously, Dr. Weir Mitchell had made measurements of the head, and in which I had made independent measurements at the time of operation, these measurements were identical, thus showing not the slightest increase in the size of the child's head during the year. One year after the operation the circumference of the head had increased 1.5 centimetres. This would lend probability to the view that, whatever may be our theory as to the cause of microcephalus,

[1] Med. News, Nov. 29, 1890.
[2] Medical Record, Feb. 21, 1891.
[3] Rev. de Chir., 1891, p. 37.
[4] Med. News, Dec. 3, 1892, p. 649.
[5] Rev. de Chir., Mai, 1891, p. 368.
[6] Amer. Journal Med. Sciences, June, 1891.
[7] Med. News, 1892, vol. lxi., p. 649.

linear craniotomy does allow of later expansion, both of the brain and of the skull.

The operation is a simple one. After the usual preparation, the line of incision being chosen, the scalp is divided either from side to side, or from the border of the hair well back on the occipital bone. A lateral incision is then made just back of the anterior border of the hair, to allow of the scalp over the forehead being drawn forward for making the groove in the frontal bone, and yet not to allow any visible scar on the forehead. Hemorrhage having been arrested by hemostatic forceps, the skull is perforated by a half-inch trephine, about half an inch from the median line, to avoid the superior longitudinal sinus. This was wounded by Halley.[1] The best instrument for gnawing away the bone

Fig. 1691.



Keen's Rongeur Forceps.

is I think the pair of forceps devised by myself (Fig. 1691), with which I have completed the entire operation in less than twenty minutes. I have very rarely been compelled to ligate any blood-vessels. The pressure of the hæmostatic forceps, and afterward of the sutures, is sufficient to control it. The bone having been gnawed away, the pericranium is detached from the flap and cut away with the scissors, so as to prevent the formation of any new bony tissue in the groove. The edges of the scalp are then united by sutures, and the ordinary dressings applied. Occasionally I have drained by horsehair, laid from end to end, but more commonly I have done without drainage. Almost invariably the wound will unite by first intention within five or six days. What the ultimate results of the operation will be when we have been able to follow such cases for 10 or 20 years, is as yet, of course, very uncertain.

Trephining for Psychoses.

These may be divided into cases of (1) Traumatic Insanity, (2) Non-Traumatic insanity, and (3) General Paralysis of the Insane.

I. Traumatic Insanity.—Although in many cases the treatment of this condition will be empirical, yet it holds out a very much better prospect of success than in the class of cases just considered.

Fletcher[2] refers to 9 previously reported cases, in which there were

[1] Journal Amer. Med. Assoc., July 15, 1893.
[2] Amer. Journal of Insanity, 1887, vol. xliv., p. 212.

6 of cure, 1 of transient improvement, and 2 of death. He himself records 8 cases, with 3 of cure, 4 of improvement, and 1 with no good result. In another article[1] he reports an additional case of melancholia with visual and auditory hallucinations, completely cured by operation. Often the mere elevation of depressed bone, or the loosening of adhesions, will afford relief.

Wade[2] reports the case of a man who was operated on three times, each one of the three operations being followed by decided improvement, and the last by cure, lasting up to the time of the report, which was, however, very recent. Frank and Church[3] report a case of presumed traumatic dementia, with personal uncleanliness. No deformity of the skull was observed, and the operation revealed no fracture. The membranes were in a state of jelly-like œdema, and four ounces of cerebro-spinal fluid escaped in a gush. Great primary improvement was followed by a relapse. A year later a second operation was done, followed by a second improvement. The ultimate result has not yet been reported. Czerny[4] records a very interesting case of hallucination of persecution, presumably brought about by an injury, as he refers to a scar. The only localizing symptoms of any value were slight paresis and hyperæsthesia of the right brachial plexus. Under the scar, increased sub-arachnoid fluid and possibly some atrophy of the convolutions were found. The dura was sunken in and the bone was thickened. The operation was followed by great improvement, but a relapse occurred two months subsequently, after coitus, and was attended by spastic paralysis. The former flap was again reflected, and improvement was noted at the time of report, which, however, was too early to warrant the presumption that it would be permanent. Czerny suggests that the improvement caused may be due to the change in intracranial pressure, similar to that in intra-ocular pressure, the diminution of which results in a cure in glaucoma. Park[5] has reported some excellent recoveries following trephining for traumatic epilepsy and insanity.

In these cases of traumatic insanity, at a longer or shorter period after the injury to the head, not uncommonly after several years, there is usually maniacal excitement, followed by chronic irritability, suspiciousness, and then homicidal impulses, with a marked tendency to dementia. The headache is often severe, and sometimes has induced the morphia habit. Generally there will have been unconsciousness after the injury, and very commonly a depressed area of bone will be found.

The operation consists simply in elevating or removing the depressed bone and loosening adhesions.

The prospect for cure in such cases is very fair; and where there is an obvious or even probable relation between the insanity and the injury, it would be eminently proper, in view of the present safety of trephining, to operate. The insanity cannot be made worse, and surely in the very few cases in which death would follow it would be an immense boon.

[1] Journal of Nerv. and Mental Disease, May, 1892.
[2] Ninety-fifth Annual Report, Maryland Hosp. for the Insane.
[3] Amer. Journal Med. Sciences, July, 1890, p. 1.
[4] Verhand. Deutsch. Gesellsch. f. Chir., 1892. [5] Med. News, 1892, vol. lxi., p. 648.

In one case of epilepsy, with marked and growing tendency toward homicidal insanity, following a blow on the head, I operated five years ago, and removed a small portion of damaged brain tissue, containing a very small cyst, the size of a pea; ultimate recovery from the epilepsy ensued, and also entire and early recovery from the homicidal mania. A year ago the patient was entirely well.[1]

Macewen[2] relates a case which is not only of importance as regards the question of insanity, but is also of peculiar importance as showing how a very careful investigation of the minute symptoms of a case may lead to a brilliant diagnosis and successful treatment:—

The patient was a man who, a year after the receipt of an injury, developed melancholia, with homicidal impulses, relieved, curiously enough, by excruciating, indefinitely located paroxysms of pain in the head. The only symptom which pointed toward the seat of the lesion was discovered by minute and careful inquiry, as follows: For about two weeks after the injury, though his sight was not impaired, what he saw conveyed no impression to his mind (mind blindness). He could not recognize a person by the eye, but by speech could recognize him readily. His New Testament was recognized readily by the sense of touch, especially its smooth leather covers and deeply indented letters; but when he opened it the words and letters were unknown symbols to him. On operation the angular gyrus was exposed, when a portion of the internal table was found detached, pressing on the posterior part of the supramarginal convolution, and a corner of it embedded in the angular gyrus. The bone was removed. Though still excitable, the patient after his recovery had no further homicidal tendency, and was at work.

II. Non-Traumatic Insanity.—Czerny[3] refers to a case of melancholia which he operated on, but he does not give the result. The most remarkable series of cases, and in fact the only ones, I believe, in which an attempt has been made to relieve idiopathic insanity by operation on the brain, are the six reported by Burckhardt.[4] These were all cases of hallucination and delirium, chiefly verbal, though to some extent of sight and hearing. Burckhardt's idea was that if he could intercept the paths of cortical association, which in his opinion transmitted the pathological impressions arising in the sensorial and ideogenous portions of the brain to the motor portion, he would be able to transform these victims of violent insanity, attended with homicidal impulses, into harmless dements. Accordingly he exposed the brain and removed a strip 2 centimetres wide from the frontal and parietal cortex, in front of and behind the Rolandic convolution, or else the centres for verbal hallucination, that is, the centres for word-deafness (first temporal convolution) and aphasia (triangular portion of Broca's convolution). His first case was typical of the others and the most remarkable of all. The patient had been insane for 16 years, with explosive outbreaks of a dangerous character both to herself and to others, so that she was necessarily put under restraint. She was exceedingly noisy, uncleanly in her habits, and so violent as to require constantly the attention of several nurses.

At his first operation, December 29, 1888, he removed a 2-centimetre

[1] Trans. N. Y. State Med. Assoc., vol. vii., 1890, p. 93.
[2] Brit. Med. Journal, Aug., 1888, p. 172.
[3] Verhand. Deutsch. Gesellsch. f. Chir., 1892.
[4] Allgem. Zeit. f. Psychiat. u. s. w., 1891, S. 463.

strip from the lateral part of the right upper parietal lobe and the supramarginal gyrus, immediately behind the Rolandic convolution. The operation lasted four hours, and five grammes of cerebral tissue were removed. Paralysis of the left arm and paresis of the left leg supervened on the tenth day, but spontaneous recovery took place in a few weeks. Although she still suffered from hallucinations, she was so much quieter that he was encouraged to do the second operation on March 8, 1889. On this occasion he removed a similar strip from the posterior part of the upper and middle temporal convolutions on the right side. The operation lasted two and a half hours, and two and a half grammes of brain tissue were removed. The patient was more cheerful after this operation, but still offensive to those about her. The third operation was done May 28, 1889. A strip of the upper and also of the lower left parietal lobe, involving the supramarginal and angular gyri behind the occipital end of the Sylvian fissure, was removed. This operation lasted four and a half hours, and five and a half grammes of brain tissue were sacrificed. She still had a few hallucinations of sight and hearing, but many of speech, and weeping and shouting were still practised, although less than before. The fourth operation was done Febuary 12, 1890, when the triangular part of Broca's convolution was removed. The operation lasted two and a half hours, and involved one and a half grammes of brain tissue. It is especially noteworthy that no aphasia followed this partial removal of Broca's centre. The four operations required thirteen and one half hours, and fourteen and one half grammes of brain tissue were removed. The result was that instead of being a dangerous lunatic the patient became harmless and mostly quiet.

The operations on the other patients were much less extensive, although each required from two and a half to three and three-quarters hours for its performance. The removal of the centre for word-deafness apparently did not produce the expected effect. One of the six patients died. The result in the first case was a satisfactory one, in view of the object sought, although it did not restore the reason. In three others the result may be said to have been fairly satisfactory. In a fifth case, after improvement to such a degree that she returned to her sister's home, the patient was found drowned, whether by accident or, as seems most likely, by suicide, is uncertain. The general impression made upon my mind after studying these cases carefully is that the results were scarcely such as to lead other surgeons to perform such operations, unless it should be in exceptionally bad cases, such as the first one. Moreover, it would surely seem that two hours should be as a rule sufficient, even for these extensive operations, and I cannot imagine that many patients would survive operations between four and five hours long, especially four successive operations. On the other hand, we must remember that Luys, quoted by Burckhardt, says that of 130 patients who were subject to hallucinations only 20 recovered sufficiently to return to their homes, and that within three or four years 15 of these suffered relapses while the other 5 were lost sight of. There is no probability of cure, therefore, by medical means. Whether this fact should justify such extensive and repeated operations is a question which may give rise to a difference of opinion among surgeons. My own judgment would be against them.

In traumatic psychoses it is very clear that operation is justifiable, and in a number of cases it has been followed by great amelioration, and in not a few by cure. The question of operation on cases of idiopathic psychoses seems to be still unsolved.

III. TREPHINING IN GENERAL PARALYSIS OF THE INSANE.—In 1889 Mr. Claye Shaw [1] reported the first case of trephining for this condition. The operation consisted in the removal on each side of a piece of bone an inch and a half by three-quarters of an inch in extent, and the evacuation of considerable fluid. The mental improvement was moderate, but the patient died six months subsequently, with no improvement in his physical condition, though with no mental relapse. In the same journal, for 1890,[2] Mr. Shaw reports a second case, and in the reports of St. Bartholomew's Hospital [3] a third, both followed by some improvement. Batty Tuke [4] reports a fourth case, with slight improvement. Rey [5] reports another, with notable improvement, of the durability of which however, he expresses some doubt. Wagner [6] reports a sixth case, with marked improvement for several weeks. Goodall [7] reports another case without any noticeable improvement. McPherson and Wallace [8] report five others. In their cases bilateral trephining was done in two; the dura was cut away in four; in one, horsehair drainage was employed. These 12 cases include, I believe, all that have been done for this condition up to the present time. The conclusion of McPherson and Wallace, that no improvement is to be expected from operation unless possibly done at a much earlier period than in any of the reported cases, seems to be justified. The pathology of the condition, whether it be due to increased pressure from cerebro-spinal fluid or to a cortical degenerative cerebritis with atrophy of the convolutions, is uncertain. But in either case, especially in the latter, the encouragement to interfere is from present experience very slight.

TREPHINING IN MENINGITIS.

For the diagnosis and symptoms of meningitis the reader is referred to Mr. Treves's article [9] in the fifth volume of this work. The question of operative interference, especially in view of the success and boldness of modern cerebral surgery, is one which has only recently arisen, and is not yet settled. Inflammation of the brain, as of other parts of the body, is followed by exudation and suppuration, and the serum or pus cannot escape from the bony skull and so relieve the pressure, as it can in the soft parts. As this exudate or pus, not being able to escape, produces rapid tissue changes and symptoms of pressure, it seems *a priori* reasonable that we should interfere surgically and offer it a means of escape by trephining, opening the dura, and draining. All surgeons are agreed on the propriety of this treatment when there is localized suppuration, but there is still much difference of opinion as to its propriety in the early stages, when the exudate is only serous, and when the

[1] Brit. Med. Journal, 1889, vol. ii., p. 1090.
[2] Ibid., 1890, vol. i., p. 1364.
[3] St. Barth. Hosp. Reports, 1892, p. 65.
[4] Brit. Med. Journal, 1890, vol. i., p. 8.
[5] Semaine Méd., 12 Août, 1891.
[6] Amer. Journal of Insanity, July, 1890.
[7] Brit. Med. Journal, 1893, vol. ii., p. 117.
[8] Ibid., July 23, 1893, p. 167.
[9] Vol. V., p. 74 *et seq.*

inflammation instead of being local is general. The fact is, however, that just as we incise the periosteum to give exit to serum or pus, as an iridectomy relieves increased intra-ocular pressure and saves the eye, or as in an orchitis an incision relieves the pain and saves the testicle; so in inflammation of the brain we have some slight experience to show that it is wise to trephine in order to drain off effused fluids before they have gone to the stage of suppuration and have inflicted irreparable damage on the brain. This mode of treatment would seem to be worthy of a fair trial, especially in that almost uniformly fatal disease, tubercular meningitis. If experience as it becomes larger is favorable, it will beget the hope that we may be able in the future to avert the dangers of cerebral inflammation far better than we have done in the past. Naturally those cases afford the greatest probabilities of cure in which there is evidence of localized rather than diffused, and especially of basilar, inflammation, and in which there is only a local production of serum or of pus. One remarkable case has been reported by Mr. Barker,[1] in which it is probable that he evacuated an ounce of odorless pus from the fissure of Sylvius, with a successful result. Sawtelle[2] records the case of a sailor who after a blow on the head developed severe headache and afterward fell into a stupor. When operated on no fracture was found, but the dura was thickened and opaque. The evacuation of five drachms of fluid was followed by complete recovery and cure. McArdle[3] relates one case in which he saved life by trephining three weeks after injury, and another in which he might have done so. Tobin[4] also has reported a successful case after trephining and draining away a considerable amount of subdural fluid, and urges early operation, even in tubercular meningitis. Mr. Parkin[5] has recorded a case of what he terms "cortical drainage," in the frontal region, for meningitis following a blow in which there were marked psychical disturbances and epilepsy. He evacuated about an ounce of clear fluid, and the boy was apparently entirely cured after seven months. Mr. Horsley has also urged this course of treatment, but as yet there is not experience enough to warrant us in saying more than that in a favorable case it would not be improper to operate. The point at which the trephining should be done should be determined, as in Mr. Barker's notable case, by localizing symptoms if these exist. Whether in general encephalitis any good result can be obtained by operative interference, is as yet very doubtful. (See Surgery of the Ventricles, p. 639.)

Trephining in Hemorrhage from Pachymeningitis Interna Hæmorrhagica.

In a number of cases, especially of alcoholism, a considerable amount of blood accumulates under the dura from that form of meningitis known as *pachymeningitis interna hæmorrhagica*. The best collection of cases with which I am familiar is given by Dennis.[6] Occasionally, as in the case of Ceci,[7] the condition is owing to accident, but much

[1] Brit. Med. Journal, 1888, vol. i., p. 777. [2] Occidental Med. Times, Feb., 1892, p. 76.
[3] Dublin Journal Med. Sciences, 1892, vol. xciv., p. 17.
[4] Brit. Med. Journal, 1892, vol. ii., p. 21. [5] Lancet, July 1, 1893, p. 21.
[6] New York Med. Journal, Dec. 24, 1892, p. 701.
[7] Von Bergmann, Chir. Behand. d. Hirnkrank., 2 Aufl., S. 179–180.

more commonly it is the result of disease. In such cases Dennis has recently urged that an operation should be undertaken. Ceci was able, even two months after the accident—which had produced palsy, incontinence of urine, and coma—to evacuate a clot, and his patient recovered and regained all the motor functions except for slight paresis of the left hand. Stewart and Annandale[1] have reported a similar case, in which, however, the result was unfavorable, probably due to the delay before trephining. Tassi[2] has reported a case which proved fatal on the seventh day from hemorrhage from the middle meningeal artery. Buchanan[3] has reported a successful case operated on two months after the accident. Four ounces of bloody serum were evacuated from the opposite side to that of the injury. Harris[4] also reports a successful traumatic case in which the symptoms were late in appearing.

Certainly all would agree that the traumatic cases should be submitted to operation. Even the alcoholic cases of subdural hemorrhage would not be made worse by trephining, and the prospect of improvement would be very great. Usually the alcoholic cases are first seen by the physician, and the surgeon is not called until it is too late to do any operation. The symptoms in such cases, as Dennis has pointed out, are first an ill-defined, dull headache, most commonly in the vertex. As the clot accumulates paralysis will supervene. The position of the clot must be determined by the doctrines of cerebral localization. The pupils will be contracted and immobile, but will dilate as soon as the clot has increased to a sufficient size. This contraction of the pupil before unconsciousness is of great diagnostic value. Optic neuritis will ordinarily supervene after a certain length of time. One of the most valuable symptoms is the final coma. The rapidity with which this sets in will depend upon the rapidity and extent of the hemorrhage. If then headache, drowsiness, paralysis, contracted and afterward dilated pupils, and optic neuritis are present, and the patient becomes comatose, with a previous history of alcoholism and without traumatism, the presumption is very strongly in favor of pachymeningitis hæmorrhagica, and as an operation could do no harm and might be followed by success, it would be proper to trephine or do an osteoplastic resection, followed by removal of the clot and probably by drainage.

Operations for Meningocele, Encephalocele, and Hydrencephalocele.

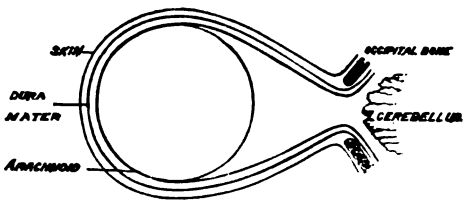
These three deformities of development are fortunately not very common. The etymology of the names is equivalent to a statement of the malformations. *Meningocele* is a tumor caused by the protrusion of the membranes of the brain only, through an aperture in the bones of the skull, the sac being filled with cerebro-spinal fluid. *Encephalocele* is a tumor caused by the protrusion of a portion of the brain itself as well as of the membranes. The fluid in both these malformations is outside the brain substance. *Hydrencephalocele* is a tumor caused by protrusion, as in encephalocele, of a portion of the brain as well as of its membranes, but in this case the interior of the mass communicates directly with the

[1] Brit. Med. Journal, 1887, vol. i., p. 877.
[2] Centralbl. f. Chir., 1893, S. 675.
[3] Pittsburgh Med. Rev., Sept., 1894.
[4] Brit. Med. Journ., 1892, vol. i., p. 503.

ventricles and is distended with a large amount of ventricular fluid. Sometimes the brain substance enclosing the fluid is reduced to a very thin film.

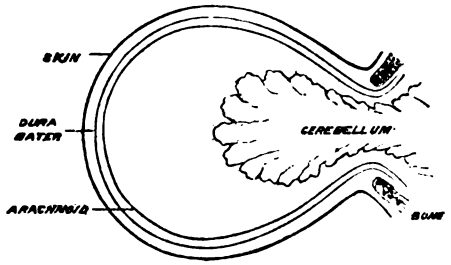
Treatment.—Until very recently the treatment of these conditions has consisted practically in electrolysis, pressure, or the injection of Morton's fluid; but the success of operations on the brain has led recently to a number of attempts to cure them by operative measures. In the "Annual of the Universal Medical Sciences" for 1889,[1] four cases of meningocele are collected, with one death. Mazzucchelli[2] reports another successful case, and Lea[3] reports two more—one of meningocele as large as a walnut (Fig. 1692), operated on at six weeks of age, the other of encephalocele operated on at eight months of age, after the

Fig. 1692.



Excision of a Meningocele. (Lea.)

Fig. 1693.



Excision of an Encephalocele Containing Part of the Cerebellum. (Lea.)

failure of Morton's fluid. The tumor (Fig. 1693) was as large as a hen's egg, and on examination a large part of the cerebellum was found to have been removed. The patient's temperature rose to 104° F., with vomiting and twitching of the arms, but by the third day became normal, and primary union was obtained. At the end of three weeks, however, hydrocephalus was beginning. I have myself reported a case[4] of meningocele in which recovery was uninterrupted. Powell[5] narrates a case of encephalocele about the size of a tennis ball which he mistook for a sebaceous cyst. During the excision, when pulling on the presumed sac, violent spasms of the right arm and leg drew his attention to the real condition. Removal of the tumor was followed by recovery without paralysis. Berger[6] has referred to a large number of cases recorded by Perrier, Jessup, Marshall, Picqué, and others. Cabot[7] also reports a case of recovery after operation. Horsley and Marshall have reported deaths.

Even hydrencephalocele, which is as a rule entirely unamenable to treatment, has been operated on at least three times with success: first, by Picqué,[8] who operated on a child 14 days old, the tumor being as large as a child's head, and portions of the cerebrum and cerebellum being removed; secondly, by Fagen,[9] who removed a tumor as large as as medium-sized orange three weeks after birth, when gangrene of the tumor had set in, tying the pedicle with four strong catgut ligatures

[1] Vol. iii., A, 53.
[2] Annals of Surg., 1892, vol. xv., p. 79.
[3] Brit. Med. Journal, May 6, 1893, p. 949.
[4] International Clinics, Oct., 1891.
[5] Brit. Med. Journal, Feb. 4, 1893, p. 232.
[6] L'Union Méd., 16 Avril, 1891; Rev. de Chir., 1890, p. 269.
[7] Trans. Amer. Surg. Assoc., 1892, p. 168.
[8] Bull. et Mém. Soc. Chir, Paris, t. xvii., p. 258.
[9] Lancet, June 4, 1892, p. 1240.

and removing a considerable amount of brain substance; thirdly by Mayo,[1] who operated on a child a year and a half old with an occipital tumor as large as a small orange, the child recovering in two weeks. It is not to be expected, of course, that the majority of such children will recover, yet the cases to which I have called attention above are quite numerous enough to authorize the statement that in suitable cases the operation should be done. Rarely advisable in hydrencephalocele, though the examples quoted show its possibility, in the other two conditions the operation will presumably be proper in a considerable proportion of cases. Of course it should be done only in those instances in which the aperture in the skull is relatively small, so that the pedicle may either be included in a single ligature or be ligated in three or four sections. Moreover, great feebleness of the child and the presence of other malformations as complications would be contra-indications.

The method is the same in all cases. The thick scalp at the base of the pedicle should be dissected away by two semilunar incisions. When the pedicle has been disclosed, if this is small enough, a single ligature may be cast around it, as close as possible to the opening in the skull. Where the pedicle is too large for a single ligature it may be ligated in several sections. The flaps of scalp should then be united over the pedicle and the wound dressed in the ordinary manner. Great care should be taken that the dressings do not become displaced, lest infection should follow, as happened in one of my recent cases with a fatal result.

Removal of the Gasserian Ganglion for Tic Douloureux.

The Gasserian ganglion, as is well known, lies in a fossa on the anterior surface of the petrous bone, near its apex. It lies between two layers of the dura, the upper layer being the dura proper, the lower layer lining the fossa in which the ganglion lies and serving as the periosteum. The first, as far as I know, who suggested operation on the ganglion was Dr. J. Ewing Mears, of Philadelphia, who expressly mentioned it as a possible necessity in cases of trigeminal neuralgia, in a paper read before the American Surgical Association as long ago as 1884. To Mr. Rose, of King's College Hospital, London, belongs, however, the credit of first actually performing the operation. His paper was published in the "British Medical Journal,"[2] and thus far he has recorded seven cases, the first six of which may be found in his Lectures on the Surgery of Trigeminal Neuralgia,[3] and in his republished monograph. The first operation was done April 2, 1890. In this case he removed the upper jaw, but took no especial care to protect the eye, which unfortunately had to be enucleated in consequence of panophthalmitis following.

His second and later cases have been done by a better method, which is practically as follows: The eyelids are first stitched together, the stitches being removed on the fourth day. (My own experience confirms that of other operators, that it is not necessary thus to protect the eyeball.) An almost semicircular incision is made, extend-

[1] Annals of Surg., July, 1893, p. 26.
[2] Brit. Med. Journal, 1890, vol. i., p. 1012.
[3] Ibid., 1892, vol. i., pp. 33, 157, 261.

ing from near the outer canthus about an inch below the external angular process, backward along the upper border of the zygoma to its posterior extremity. It is then carried down over the parotid region just in front of the ear to the angle of the jaw, and then forward along the lower border of the horizontal ramus as far as the facial artery. The flap of skin thus marked out is dissected forward. Two holes are then drilled at each end of the zygoma to facilitate later wiring, and the zygoma is divided and displaced downward along with the masseter muscle. The coronoid process is similarly drilled, divided, and turned upward with the tendon of the temporal muscle. In Mr. Rose's latest cases this portion of the bone was entirely removed as useless, and doing this dispenses with the need of drilling it. The external pterygoid muscle is next scraped loose from the sphenoid bone, and the foramen ovale is found. At first Mr. Rose put the blunt end of the centre-pin of his long-handled half-inch trephine through the foramen ovale, but afterward, on account of the danger of encroaching on the Eustachian tube and the possibility of infection from this tube (his fifth case died from meningitis probably due to such infection), he placed the sharp end of the centre-pin a little external and anterior to the foramen, so that the edge of the trephine opening should be at the foramen itself. The thin lining of the fossa in which the ganglion lies (the lower layer of the dura mater) is then divided, and the ganglion as far as possible removed. If the internal maxillary artery or vein is in the way, it is double-ligated and divided. Care must be taken not to divide the upper layer of the dura above the ganglion (the true dura itself), for by so doing the subdural cavity would be opened. On the inner side the carotid artery and the cavernous sinus must also be avoided. An electric light is almost a necessity.[1] The second and third divisions of the fifth nerve are readily found and removed, with as much of the ganglion as can be taken away by Rose's special hooks, or by a small sharp spoon. Fowler has proposed to attempt the removal of the sensory portion of the ganglion, leaving the motor root intact. Whether this is feasible has not yet been demonstrated. It is certainly desirable, but there is a possible danger that the attempt to preserve the motor root might cause imperfect removal of the sensory portion of the ganglion, and so nullify the whole operation. Of Mr. Rose's 7 patients, 6 recovered, and of these, 5 at the time of the last report were entirely free from pain, the first having been so for nearly two years. One very nervous patient had slight recurrence.

Andrews,[2] of Chicago, has also devised several operative methods which differ but little from Rose's. Mr. Horsley[3] proposed an intra-dural method and has operated once. He made a large opening through the squamous portion of the temporal bone, opened the dura, lifted the temporal lobe so as to see the roots of the fifth nerve emerging from the pons, from which they were removed by avulsion. His patient unfortunately died in seven hours from shock. Richardson has

[1] The best light is that of W. A. Hirschmann, of Berlin. It is very bright, and the light can be thrown in any direction, thus making it useful in all other surgical work requiring such illumination. Otto Flemming, of Philadelphia, has made me a very satisfactory storage battery to work the lamp.

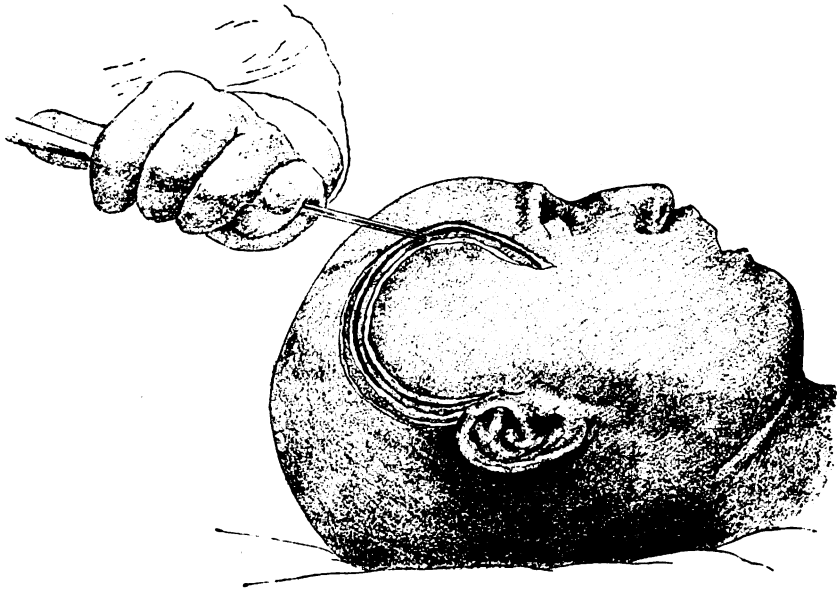
[2] Journal Amer. Med. Assoc., 1891, vol. ii., p. 168; and 1893, vol. i., p. 180.

[3] Brit. Med. Journal, 1891, vol. ii., p. 1191.

done one operation by this method successfully. The roots of the fifth nerve were not torn from the pons, but were cut by scissors.

Hartley, of New York,[1] has published still another extradural method, as follows. (Figs. 1694, 1695.) A large osteoplastic flap of scalp, muscle, and bone is made in the region of the temple. This flap should

Fig. 1694.



Hartley's Operation for Removal of the Gasserian Ganglion; Separating the Flap.

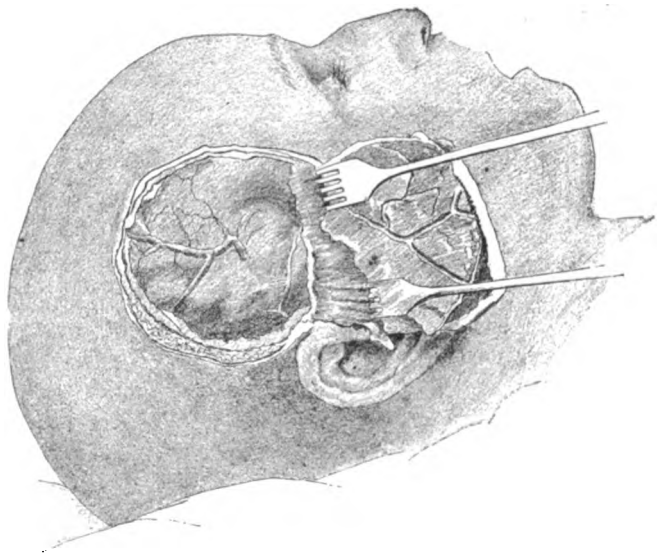
begin just in front of the auricle, a little above the zygoma, the base being about two inches antero-posteriorly, and the height of the flap three inches. It is best made with Hartley's or Pyle's chisels. By two or three elevators placed under the circumference of the bone the flap is raised and its base fractured; the flap is then turned down, exposing the dura. The middle meningeal artery may if necessary be ligated, either now or subsequently, just above the foramen spinosum. By the finger the dura is next stripped from the floor of the middle fossa. Care must be taken during this separation that the middle meningeal is not torn at the foramen spinosum. In one of my cases the artery was torn so close to the foramen that it could not be tied. The hemorrhage was gradually controlled, first by the finger and then by packing with iodoform gauze. The dura is separated until the second and third divisions of the nerve are seen. These are divided at their foramina, their distal ends pushed through the latter, and their proximal ends or stumps traced back to the ganglion. The nerves should be exsected together with the ganglion, or the ganglion itself may be destroyed as before. The ganglion in a very few cases has been removed as a recognizable mass. In Stewart's case (see Table) the first division was removed with the ganglion, and yet, strange to say, no trophic changes took place in the eye. Krause[2] has described a precisely similar operation,

[1] New York Med. Journal, March 19, 1892, and Annals of Surgery, May, 1893, p. 512.
[2] Archiv f. klin. Chir., 1892, Bd. xliv., S. 821.

independently of Hartley, by whom, however, he was anticipated both in its performance on the living subject and in publication of the method. In Krause's case, to check hemorrhage the space between the dura and the bone was packed with iodoform gauze, and under anæsthesia on the fifth day the nerves were divided. I have found this method of performing the operation in two stages very useful, and have adopted it in two out of the three cases I have operated on. In one of them I packed the cavity with a piece of gauze thirty-seven inches long and six inches wide, to arrest the hemorrhage, and left it in the cavity of the skull for three days. No mischief resulted from it.

In removing the ganglion care must be exercised not to injure the carotid artery, which can, however, easily be felt and identified by the finger. But more especially must the surgeon be careful of the cavernous sinus, as it cannot be recognized with any certainty, its walls being tense and there being no pulsation. It is an encouragement to know that in Stewart's case, though the cavernous sinus was opened, yet packing with sponges wrung out of hot water arrested the bleeding, and the operation was successfully terminated, the patient recovering.

Fig. 1695.



Hartley's Operation for Removal of the Gasserian Ganglion; the Flap Turned Down.

In the following table I have collected all the cases which I have found thus far reported. They include cases operated on by every method, and of the 62 cases only 12 have ended fatally, 19.3 per cent., a small mortality, considering the character and newness of the operation. Thus far there has been a moderate recurrence of the neuralgia in one case of Rose's and in one of my own. It must be remembered, however, that the operations have been reported after a comparatively brief period. It is therefore too early to give a definitive opinion as to the permanency of the cure. It is thus far, however, apparently both a very successful operation and a not very dangerous one. Should a longer experience prove it to be efficacious, it may possibly become the operation of first

choice in very severe cases of tic douloureux. Should it, however, prove unsuccessful as a permanent means of arresting the pain, it should then be our last resort, and a wise surgeon would begin by the most peripheral operation, and gradually approach the ganglion from time to time, as forced to do so after various recurrences. Even then it would hold apparently an important place as a final means of relief.

OPERATIONS FOR THE REMOVAL OF THE GASSERIAN GANGLION.

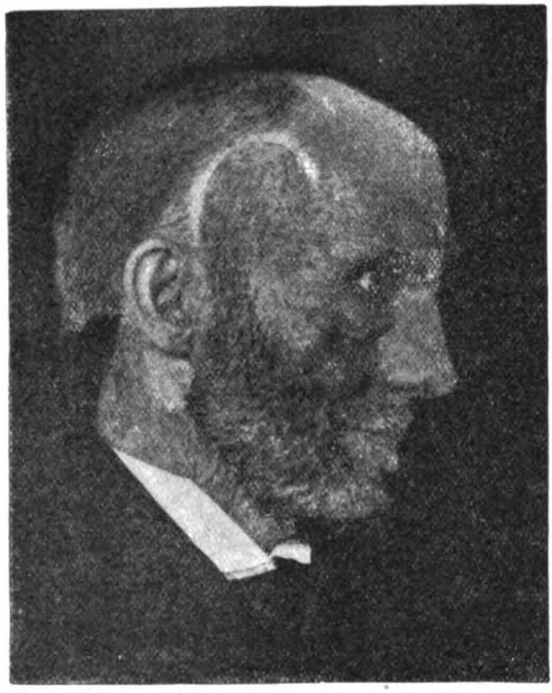
Author.	Reference.	Recov.	Died.	Total.
(*c*) Horsley	Brit. Med. Jour., 1891, vol. ii.. p. 1191	..	1	1
(*b*) Rose	Brit. Med. Jour., 1892, vol. i., p. 261	5	..	5
(*b*) Id	Lancet, 1892, vol. ii., p. 953	1	1	2
(*e*) Fernandez	Siglo Med., Madrid, 1892, pp. 804, 819; 1893, pp. 4, 18, 36	..	1 ..	1
(*a*) Roberts	Proc. Phila. Co. Med. Soc., 1892, p. 490	1	..	1
(*b*) Kerr	Jour. Amer. Med. Assoc., Feb. 18, 1893, p. 181	1	..	1
(*b*) Lanphear	Pacific Med. Jour., vol. xxxv., 1892, p. 637	1	..	1
(*b*) Park	Med. News, Feb. 18, 1893, p. 183	2	..	2
(*b*) Andrews	Jour. Amer. Med. Assoc., Feb. 18, 1893, p. 180	3	1	4
(*a*) Hartley	Annals of Surgery, May, 1893, p. 511	1	..	1
(*b*) Parkhill	Med. News, Sept. 16, 1893, p. 319	1	..	1
(*a*) Krause	Annals of Surgery, Sept., 1893, p. 362	5	..	5
(*a*) Finney	Johns Hopkins Bulletin, Oct., 1893	2	1	3
(*a*) O'Hara	Austral. Med. Jour., Oct. 15, 1893	1	..	1
(*b*) D'Antona	Brit. Med. Jour., 1893, vol. i., p. 81	1	..	1
(*b*) Doyen	Rev. de Chir., 1893, p. 391	2	1	3
(*b*) Camponotto	Brit. Med. Jour., Epitome, 1893, p. 102	..	1	1
(*a*) McBurney	Annals of Surgery, 1893, vol. i., pp. 516, 519	2	..	2
(*a*) Keen & Mitchell	Trans. Phila. Co. Med. Soc., 1894	1	..	1
(*a*) Tiffany	Annals of Surgery, Jan., 1894, p. 47	4	..	4
(*b*) Eskridge & Baker	Amer. Jour. Med. Sciences, March, 1894, p. 291	..	1	1
(*a*) Fowler	Med. Record, June 16, 1894, p. 745	1	1	2
(*b*) Stewart	Med. News, Aug. 11, 1894	1	..	1
(*c*) Richardson and Walton	Boston Med. and Surgical Jour., Nov., 1894	1	..	1
(*b*) Dennetières	Rev. de Chir., 1894, p. 970	1	..	1
(*d*) Quénu	Gaz. des Hôp., 1894. No. 5	1	..	1
(*a*) Thorn	Annals of Surgery, March, 1895, p. 296	1	..	1
(*b*) Lanphear	Jour. Amer. Med. Assoc., April 6, 1895, p. 507	1	..	1
(*a*) Griffith*	Ibid., p. 508	..	1	1
(*a*) Buchanan	Med. News, April 27, 1895	1	..	1
(*a*) Tiffany	Annals of Surgery, May, 1895	3	..	3
(*b*) Eskridge & Rogers	Amer. Jour. Med. Sciences, June, 1895	1	..	1
(*b*) Camponotto†	Brit. Med. Jour., Epitome, 1895, vol. i., p. 37	..	1	1
(*b*) Dandridge	Boston Med. and Surg. Jour., 1895, vol. i., p. 397	1	..	1
(*a*) Mixter	Ibid , p. 412	1	..	1
(*a*) Keen	Unpublished	1	1‡	2
(*b*) Cheever	Personal communication	1	..	1
		50	12	62

Summary.	Total No.	Recov.	Died.	Mortality Per Cent.
(*a*) Hartley's method	29	25	4	13.8
(*b*) Rose's "	29	23	6	20.7
(*c*) Horsley's "	2	1	1	50.0
(*d*) Combined " of Hartley and Rose	1	1	..	..
(*e*) Unknown " Reference could not be verified	1	..	1	100.0
	62	50	12	19.3

* Ganglion not removed on account of hemorrhage. Death from meningitis on third day.
† This is said to be Camponotto's third case. I have not seen a reference to his second.
‡ This patient died from an infection by an assistant.

Of all the methods proposed, that of Hartley and Krause seems to be the best. Rose's operation has the disadvantages that the muscles of mastication on one side are paralyzed, and that the lower jaw may be displaced so that the teeth are no longer opposed. The parotid has been wounded and the seventh nerve paralyzed. The immediate proximity of the trephine opening to that of the Eustachian tube has twice induced death from septic meningitis. In the small number of cases thus far reported, the mortality by Rose's method is somewhat greater than by Hartley's. Fig. 1696 shows the result in one of my cases.

Fig. 1696.



Successful Removal of Gasserian Ganglion by Hartley's Method. The last of fourteen operations for tic douloureux.

Surgery of the Lateral and Fourth Ventricles in Relation to Increased Intracranial Pressure.

Puncture of the lateral ventricles through the anterior fontanelle for hydrocephalus is an old operation, but in 1881 Wernicke first proposed trephining and puncture of the ventricles in completely ossified skulls, and again Zenner, of Cincinnati, in 1886 made a similar suggestion. The first publication, however, in which the steps of the operation were distinctly formulated was a paper which I read before the College of Physicians of Philadelphia, on Nov. 7, 1888.[1] In August, 1890, before the Tenth International Medical Congress in Berlin, I presented an elaborate paper, covering the whole surgery of the lateral ventricles up to that time.[2]

The earliest case in which the operation was done, though not reported till after my paper was published, was that of von Bergmann,[3] on July 15, 1887, and the second operation was by Ayres and Hersman on Dec. 4, 1888.[4] The third case operated on was my own, on Jan. 11, 1889, and the fourth was that of Mr. Mayo Robson, on Feb. 7 of the same year.[5] Since then a considerable number of cases have been operated on, some of which will be referred to hereafter.

[1] Med. News, Dec. 1, 1888.

[2] Unfortunately the MS. of this paper, of which I had no copy, was lost by the authorities of the Congress, and only a *résumé* was printed in the Med. News, Sept. 20, 1890, Lancet, Sept. 13, 1890, and Rev. de Chir., 1891, p. 45.

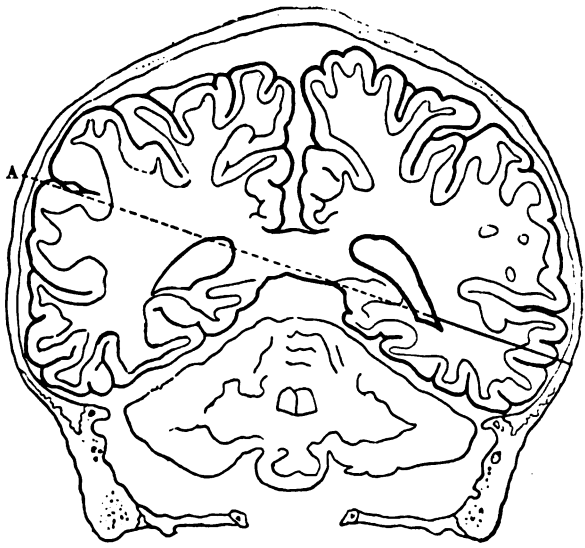
[3] Chir. Behand. d. Hirnkrank., 1889.

[4] Pittsburg Med. Review, March, 1889.

[5] Brit. Med. Journal, Dec. 6, 1890.

In my first paper I described three different routes by which the lateral ventricles could be reached; the frontal, the occipital, and the lateral. The lateral is decidedly the best route (Fig. 1697), inasmuch as it passes through no important brain centres, and by it the ventricles can be reached with accuracy. A trephine opening half an inch in diameter is made an inch and a quarter behind and the same distance above the meatus. The brain is then punctured by a tube, No. 5 of the French catheter scale, or by any other suitable instrument, directed toward a point (A) 2½ inches vertically above the opposite meatus. At a depth of about 1¾ or 1½ inches, or less, according to the distention of the ventricle, its cavity will be reached. This can almost always be determined by a sudden diminution of pressure, and by the immediate escape of the cerebro-spinal fluid. Continuous drainage may be kept up, in small amount, by three or four stout, doubled horsehairs, introduced through a canula, or by a rubber or other drainage tube.

Fig. 1697.



Puncture of Lateral Ventricles by Lateral Method.

In my first case, on the 32d day, by a fountain syringe, the bag of which was raised 6 inches above the head, after tapping the opposite ventricle, the cavities of the two ventricles were irrigated from side to side by a warm boric-acid solution, gr. iv. – f ʒ i., with not a little comfort to the child. Boiled water, which was used two days subsequently, gave less relief, but produced no ill effects. The child died on the 45th day, the wound remaining absolutely aseptic. Finding the drainage too sudden, and that the withdrawal of the fluid produced convulsions, in my second case I siphoned from a height of 8 inches, 8 times in succession, from half an ounce to an ounce of warm boiled water, each siphonage being followed by an arrest of the convulsions.

The object to be attained by this operation may be the relief or cure of hydrocephalus or porencephalus, the relief of intracranial pressure, or possibly the evacuation of an abscess or of a collection of blood in the ventricles.

The conditions of chronic hydrocephalus and porencephalus may be considered together, as they are not unlike. It is probable that only a very small number of cases of hydrocephalus can thus be cured, but the disease is so distressing and fatal that an attempt to give relief in reasonably favorable cases seems proper, especially as there are on record several instances in which benefit has been obtained. Among those terminating fatally were my own second and third cases, and several re-

corded by Thiriar,[1] Andry,[2] Phocas,[3] Mayo Robson,[4] Manny,[5] Walker,[6] and others. But on the other hand Broca[7] reports a case with contracture of the left arm in which the right ventricle was drained for two weeks, and in which the operation was followed by entire relief of the contracture, so that the child could use its arm; by the disappearance of the strabismus; and by the beginning of the ability to walk at the time the case was last seen, six weeks after the operation. In a case recorded by Phocas there was improvement, and the child was living four months afterward. In addition to this, Kocher[8] has reported two cases of recovery after operation for porencephalus, which are especially worthy of notice.

The first patient, a child of 15, had a fall at one and a half years of age. At four, attacks of unconsciousness developed, and subsequently epileptic attacks, beginning in the left arm, which became paretic. At the operation, Feb. 26, 1889, the skull was trephined in the occipital region, and a large porencephalic cavity was opened, laying open the lateral ventricle, so that the choroid plexus was seen. Drainage, with copious flow of cerebro-spinal fluid, was kept up for four weeks. The flow altered greatly with the position of the child, and it is remarkable that as an aid to evacuation of the fluid the head was bent forward, so that the air was sucked into the sac, and on replacing the head in the vertical position the fluid escaped freely, yet no infection seems to have followed. At first arrest of drainage caused renewed attacks, but finally the fistulous track of the drainage tube healed, and the child entirely recovered.

The second patient, a girl of 17, had her head injured by forceps at her birth. Her epileptic attacks set in at 3 years of age, as many as two to three in a day. A large porencephalic cavity was found in the anterior part of the brain, leading into the lateral ventricle, and the corpus striatum was seen. Two hundred cubic centimetres of fluid were evacuated, and three months afterward the drain had closed and the girl had recovered.

I have seen but a single case operated on,[9] one with athetoid movements, in which the patient died after the operation, of scarlet fever. The porencephalic condition of the brain was not recognized until the operation revealed it.

In acute hydrocephalus, the case of Mayo Robson[10] is the first one which has ended in recovery after operation. Hahn[11] reports a still more noteworthy case, of a butcher 35 years of age, who suffered from entire blindness in one eye, with impairment of hearing and smell, loss of memory, and headache. Cysticercus was suspected, and he was trephined in the frontal region. The conclusion was reached that the very marked increasing bulging of the brain through the opening was due to intraventricular pressure, whereupon the ventricle was punctured with a hypodermic needle, and 120 cubic centimetres of watery fluid were withdrawn. The brain substance receded at once, and recovery was complete, except for monocular blindness. Soderbaum[12] has reported the case of a girl, almost in a comatose condition, with facial palsy, convulsions, and vomiting, whom he trephined, making

[1] Broca, Rev. de Chir., 1891, p. 37. [2] Progrès Méd., 1892, No. 9.
[3] Rev. Mens. des Malad. de l'Enfance, Fév., 1892. [4] Loc. cit.
[5] Rev. de Chir., 1893, p. 388. [6] Med. and Surg. Reporter, vol. lxiii., p. 216.
[7] Loc. cit. [8] Deutsche Zeitschr. f. Chir., Bd. xxxvi., 1893, S. 72.
[9] Willard and Lloyd, Amer. Journal Med. Sciences, April, 1892. [10] Loc. cit.
[11] Twenty-second Cong. of German Surgeons, 1893; Med. News, May 6, 1893, p. 500.
[12] Annals of Surgery, 1892, vol. xv., p. 467.

several deep punctures and evacuating "an unusual quantity of serum." Entire recovery followed. The author suggests that either a cyst or the ventricle was punctured. It would seem probable that the latter was the more likely conclusion.

McCosh [1] narrates a case in which there was doubtful prior epilepsy. Subsequently, at 29 years of age, the patient fell downstairs. This was followed by partial and temporary paralysis of the left arm. Epileptic convulsions ensued, as many as five in the 24 hours, with rapidly increasing weakness and headache. A quarter-inch button of bone was removed over the lateral sinus; no clot was found, but there were evidences of great intracranial pressure, and there was marked bulging of the brain. Punctures in different directions gave no result. Finally, by puncturing the right lateral ventricle fluid was found. An ounce of fluid was drained off in 48 hours, when the canula was removed. At the end of two weeks the patient was out of bed, and in five weeks there was entire recovery, with no headache.

Markedly increased, acute, intracranial pressure is due commonly to an accumulation of cerebro-spinal fluid in the ventricles, not only from hydrocephalus, but especially from pressure on the aqueduct of Sylvius, chiefly by tumors of the pons or cerebellum. It is of course impossible to expect any cure from the mere evacuation of the pent-up cerebro-spinal fluid, but the relief which was obtained in a case reported by Mills and Hearn [2] was so noticeable that, as a palliative measure, it seems entirely justifiable. In this case the patient was blind and deaf, and the only means of communicating with him was by tracing German letters on the palm of his hand. His headache was atrocious, so that life was absolutely a burden. At the operation Dr. Hearn tapped the lateral ventricle, withdrawing a large amount of fluid; and though the patient died on the fifth day, yet the relief which he obtained from his intense headache was as justifiably procured by this surgical procedure as it would have been by a hypodermic injection or other medical means. The lessened suffering in my first case, in which a tumor of the cerebellum was found, was quite marked. Diller [3] records also a case of tumor of the pons in which he tapped the ventricle, with relief of pressure, although there is no especial statement as to the influence on the suffering of the patient.

Instead of draining the cerebro-spinal fluid directly from the ventricles by tapping them, Wynter [4] proposed to drain it away indirectly by puncturing the membranes of the cord in the lumbar region. He has reported four cases, with temporary improvement, but ending fatally. Quincke [5] has reported ten similar operations for hydrocephalus, the treatment being combined with pressure on the skull at the same time. One patient was cured. In two cases the result was probably due to the other means employed. In three there was temporary improvement. None of the patients died. Ziemssen [6] has also operated on some cases.

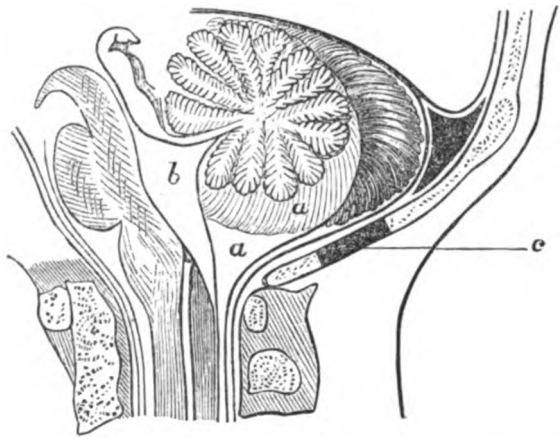
Quincke calls attention to the fact that in infants the cord extends to the third lumbar vertebra, and that hence the puncture should be

[1] Med. Record, Sept. 16, 1893, p. 376.
[2] Phila. Hosp. Reports, vol. i., p. 270, and Proc. Phila. Co. Med. Soc., Dec. 11, 1890.
[3] Amer. Journal Med. Sciences, 1892, vol. ii., p. 509.
[4] Lancet, 1891, vol. i., p. 931.
[5] Berl. klin. Woch., 1891, Nos. 38, 39.
[6] Verhandl. d. 12ten Kongress. f. inner. Med., 1893, S. 197.

made in the third or fourth intervertebral space. This measures 18 to 20 millimetres transversely and 10 to 15 millimetres longitudinally, the cauda equina being in two lateral bundles with an interspace of 5 millimetres. The depth of the puncture to reach the cord in infants is about 2 centimetres, and in adults from 4 to 6 centimetres.

Parkin [1] has proposed and practised still another method. (Fig. 1698.) He trephined three-quarters of an inch below the superior curved line of the occipital bone, just to the right of the middle line, and enlarged the opening downward by a rongeur forceps. After opening the dura he inserted a probe into the fourth ventricle, lifting the cerebellum to a slight extent, when two to three ounces of fluid "gushed out." Temporary improvement was followed by death in 16 hours after the operation. Morton,[2] commenting on this procedure, calls attention to the fact pointed out by him [3] that the opening between the fourth ventricle and the subarachnoid space of the cord is always patent in tubercular meningitis, but he doubts whether Parkin's operation will do any good, and objects to it as involving a dangerous locality. Parkin [4] has reported four cases with two recoveries, and Ord and Waterhouse [5] have recorded another recovery.

Fig. 1698.



Vertical Section of Base of Skull immediately to Right of Median Line. *a*, Basal subarachnoid cavity and its relation to cerebellum; *b*, fourth ventricle; *c*, site of trephine opening. (Parkin.)

Abscess Bursting into the Lateral Ventricle.—It is of course very rare that it would be possible to save life in so fatal an affection as abscess of the brain bursting into the lateral ventricle. I know of no recorded case in which this has been accomplished. Sheen,[6] however, reports the case of a patient who received a blow on the head, followed by an abscess which was evacuated and drained for three weeks. The autopsy revealed the fact that the tube was in the lateral ventricle. Certainly in so fatal a disease the resort to a desperate remedy seems justifiable, unless experience shall show that it will be of no value. In case of rupture of an abscess into the ventricle, I should propose instant bilateral trephining and washing out of the ventricles with a boric-acid solution. It must not be forgotten, however, that the foramen of Monro is sometimes closed, when only one ventricle could thus be washed out. Usually, however, in that case only one side would be involved in the disease. Such closure has been reported by me in my third case, and also by Pott.[7]

[1] Lancet, 1893, vol. ii., p. 21.
[2] Ibid., p. 194.
[3] Brit. Med. Journal, 1893, vol. i., p. 741.
[4] Lancet, 1893, vol. ii., pp. 23, 1244.
[5] Ibid., p. 873.
[6] Brit. Med. Journal, 1890, vol. i., p. 236.
[7] Med. News, Sept. 20, 1890, p. 290.

Hemorrhage into the Lateral Ventricle.—Dennis[1] removed a clot in a patient aged 36 years, who had received a blow on the head and was trephined six hours after the accident. No clot being found, either outside or under the dura or in the brain substance, an incision was made directly into the ventricle, when a clot about the size of a pullet's egg shot out with such force as to fall several feet away from the patient's head. Death followed, however, in three days, as a result of the great laceration of the cerebral substance.

The ventricles have also been ruptured in cases of compound fracture, two such cases at least having been recorded, both ending in recoverey. Of secondary rupture of the ventricles quite a large number of cases are now on record, and in over one-half recovery has followed surgical treatment. In my paper before the International Congress I called attention to five cases of rupture of the lateral ventricles from simple fracture, all in young children, and three terminating favorably. In such cases as a rule no operative interference should be attempted unless threatening symptoms supervene.

[1] New York Med. Journal, 1892, vol. lxvi., p. 701.

INJURIES OF THE BACK.

BY

LEWIS A. STIMSON, M.D.,

PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF THE CITY OF NEW YORK.

DISLOCATIONS, FRACTURES, AND FRACTURE-DISLOCATIONS OF THE VERTEBRÆ.

IT seems desirable, in view of the increasing frequency of resort to operation in spinal injuries, to call attention to the possibility of complete, irremediable, instantaneous destruction of the spinal cord without permanent displacement or recognizable deformity of the column. The injury appears to be produced in some cases by overstretching of the cord in forced flexion of the column, especially in the cervical region, aided sometimes by fracture of one or both laminæ; when the flexion ceases the parts are at once restored to place, and no deformity remains to indicate what has occurred.

The following case, reported by Dr. Edward O. Otis,[1] is quoted in illustration:

A lad, 17 years old, fell about five feet, head-foremost, upon a mattress in a gymnasium, striking in such a way that his head was bent so far forward that his face must almost have rested upon his breast. Complete paralysis from a little below the clavicles. He survived until the sixth day. The autopsy showed a fracture of the laminæ of the fifth and sixth cervical vertebræ, but no displacement, and no rupture of any of the ligaments of the spinal column. At the point corresponding to the fracture the dura was moderately injected, and the cord was soft and diffluent.

A somewhat similar case was reported by Dr. McBurney to the New York Surgical Society in 1892; the patient, an elderly man, fell downstairs and was completely paralyzed below the neck, except the diaphragm. He survived a week in perfect bodily comfort and died suddenly. The autopsy showed a transverse horizontal fracture of the body of one of the cervical vertebræ without displacement, and a complete division of the cord.

TREATMENT OF FRACTURES AND FRACTURE-DISLOCATIONS.—It is not easy at the present time to lay down positive rules for the treatment of these injuries, for various modifications of, or additions to, those that have heretofore seemed proper and sufficient are now undergoing trial. The tendency is decidedly toward more active interference; attempts

[1] Boston Med. and Surg. Journal, Sept. 15, 1892.

are made to correct displacements by traction, by direct pressure, and by bending the spine, usually backward; the latter may be effected by passing a stout bandage under the patient as he lies on his back, so that it rests against the projecting spinous process—for example, at the lower dorsal or lumbar region—and then lifting the body by means of this bandage.

Traction is made by fixing the head, or the head and shoulders, and then raising the end of the bed or the plank upon which the patient rests so that the body shall tend to slide gently downward away from the head.

Immediate fixation to secure such gain as has been thus obtained may be effected by a plaster-of-Paris jacket. A more convenient method than the use of the ordinary roller bandage is to prepare a pad of about a dozen thicknesses of crinoline of suitable length and breadth, and saturated with plaster cream; this is passed under the patient, and the ends are brought up on either side to overlap in front. A smoother fit can sometimes be got by splitting the ends so as to make a "many-tailed" or Scultetus bandage.

Dr. Woodbury, of New York, has adopted the ingenious plan suggested in cases of Pott's disease by R. Davy, of suspending the patient horizontally upon a strip, or sort of hammock, of stout muslin, and then including it in the turns of a plaster roller. After the plaster has set, the muslin is cut off at the upper and lower edges of the jacket.

In some cases the application of a plaster jacket, without any attempt to rectify any displacement that has been present, has been promptly followed by marked amelioration of the symptoms and an ultimate cure. On the other hand, traction by partial suspension, as just described, has occasionally given rise to unfavorable, and even to alarming, symptoms. On the whole, it seems proper to say that we have, in cautiously made partial suspension by the head, or head and shoulders, a safe means for correcting or diminishing certain displacements after fracture, and in immobilization of the trunk by a plaster-of-Paris jacket a means of avoiding secondary or recurrent displacement during repair.

Operative Treatment.—The experience gained during the last few years has shown that under the protection of modern methods of operating and dressing, the dangers of cutting down upon the spinal column and opening the spinal canal are much less than they formerly were, or were supposed to be. Unfortunately an affirmative gain, the proof of its ability to relieve, has not been so fully established. This experience has been collected and thoroughly studied by Dr. J. William White in a paper read before the American Surgical Association in 1891, and published in its Transactions for that year. To it the reader is referred for details that cannot be repeated here.

In order to determine as far as possible the present risk of such operative interference, Dr. White has collated only those cases in which the wound was treated antiseptically; there are 37 operations for fracture, with 6 complete recoveries, 6 recoveries from the operation with benefit, 11 recoveries unimproved, and 14 deaths, a mortality of thirty-eight per cent. In how many of these cases the fatal result was occasioned or hastened by the interference cannot, of course, be positively deter-

mined, but a review of the histories indicates that asepsis is as potent to prevent inflammation of the cord and its membranes, as well as suppuration of the wound, as it is to prevent similar complications of wounds of other regions; that serious hemorrhage is not to be feared, although one of the deaths appears to have been caused by it; and that the loss of cerebro-spinal liquid is without important consequences. Moreover, the removal of the spinous processes and laminæ of even several adjoining vertebræ does not appear seriously to weaken the spinal column. This seems satisfactorily to remove the objection against interference based upon the theory that in itself it seriously endangers the patient's life, and relieves its advocates from the necessity of showing great gains to compensate for great risks. Even small gains may be a sufficient justification.

The indications for operation are to relieve pressure upon the cord by fragments, by the displaced vertebræ, or by extravasated blood, and, if necessary and practicable, to correct deformity. The relief of pressure upon the cord in order to favor the re-establishment of function and oppose secondary ascending degeneration, is the chief, and practically the only, indication. The question before us, then, is: to what extent are we justified in believing that this indication can be met by operation? Until within a few years it was very generally believed that, in almost all cases of fracture, the pressure was made upon the front of the cord by the upper edge of the body of the vertebra across which it was stretched by the bodily displacement forward of the next upper vertebra, and the inaccessibility of this projecting edge was one of the reasons urged against operation. Later investigations have shown that the proportion of cases in which the fracture is limited to the laminæ, and in which the pressure is made by a depressed portion of the posterior arch, is very much larger than was supposed, and several operations have shown that even in the other and commoner form the resection of the posterior arch of the upper vertebra, the one that has been displaced forward, will sometimes relieve the pressure upon the cord, which is pinched between this arch and the underlying vertebral body rather than stretched across the latter. In such cases the operation is fully competent to relieve. When the pressure is made by blood extravasated within the canal, or within the dura, the operation is also competent to relieve, but it is powerless against hemorrhage into the central canal or into the substance of the cord.

In respect of the degenerative changes in the cord set up by the traumatism, it can only be said that in some cases they begin promptly, advance rapidly, and do not disappear on the removal of pressure, while in others marked improvement has set in after the lapse of many weeks. Possibly in the first group the original injury has been a crush or laceration of the cord, not simply its compression.

Examination of the results according to the region involved shows that the proportion of successes is very much greater in injuries of the lumbar and lower dorsal vertebræ than in those at higher points. Injuries of the cauda equina resemble those of peripheral nerves rather than those of the cord, and the hope of restoration of function after the relief of pressure is much greater. So, too, in injuries of the lower portion of the cord, while the cord itself may be permanently disabled, the enveloping nerves originating at higher points may regain their function.

Probably the recognition of a condition of the cord that may be benefited by operation will not often be possible, and the operation, if undertaken, will almost always begin as an exploration, so that in most cases the question that the surgeon has to ask himself is, whether or not an exploration is likely to furnish information the importance of which will outweigh the dangers of the exploration itself.

In certain groups of cases this question, according to our present knowledge, must be answered in the negative. In recent cases of fracture by forcible flexion (indirect violence) of the cervical or upper dorsal spine, in which there is paraplegia but little or no displacement, operation seems unjustifiable because of the probability that the cord has been completely divided or pulpified; and the same argument and conclusion will apply in fractures at any point, effected by great violence and accompanied by marked displacement.

In recent cases of fracture by direct violence, cases in which depression of a portion of a posterior arch can be made out or reasonably suspected, operation is justifiable, especially if the injury is in the lower dorsal or lumbar region.

Other cases in which operation is deemed justifiable are those in which degenerative changes appear promptly and rapidly increase, those in which the cauda equina alone is compressed, those in which it is believed that the cord is compressed between the posterior arch of one vertebra and the body of the adjoining one, and those cases in which after the lapse of eight or ten weeks improvement in function has remained wholly absent or has ceased, bed-sores have formed, and there is incontinence of urine or fæces.

In short, in the present state of our knowledge, the immediate risks connected with an exploratory incision into the spinal canal are so small that such an exploration may properly be undertaken whenever there is a reasonable expectation that it will disclose a condition of the cord that can be relieved.

The details of the operation, as described by White, are in the main as follows: The patient lies face downward. An incision, from four to six inches long, is made in the median line along the spinous processes, its centre opposite the seat of the fracture; the muscles on each side are separated from the spines and laminæ, and the periosteum is stripped from the latter. Hemorrhage must then be completely stopped by ligatures, clamps, and sponge-pressure. The muscles on each side are drawn aside with sharp retractors, and one or two spinous processes cut away close to their bases with strong forceps. This greatly facilitates approach to the laminæ. The laminæ are next cut through as close as possible to the transverse processes with bone forceps, rongeur, saw, chisel, or small trephine, and after removal of the central portion the opening may be enlarged laterally by cutting away the stump with the rongeur.

Some surgeons, such as Dr. Abbe, have sought to expedite the operation, and to diminish the amount of bleeding and interference with the solidity of the spine, by making the incision close beside the spinous processes and stripping the muscles away on one side only; then three or four spinous processes are isolated by cutting through the interspinous ligaments above and below them, and they are next cut away from the laminæ with forceps or rongeur; they can then be retracted

en bloc toward the other side, so as thoroughly to expose the whole of the posterior arch, when the laminæ are cut away piecemeal with the rongeur.

If the presence of blood or pus respectively within the dura is indicated by a dark purplish or yellowish color, it will be proper to open into the subdural space, which is best done by picking up the dura in the median line with fine forceps and cutting through it with scissors. This incision may be closed with fine sutures.

GUNSHOT WOUNDS OF THE SPINE.

Further experience has shown that the prognosis under antiseptic treatment is rather better than it was thought to be ten years ago, and even that operative interference is not to be quite so absolutely rejected. Vincent[1] has collected thirty-three cases, many of them of recent date, and has carefully reviewed the subject. Bacteriological examination of the bullets of fixed ammunition has shown that they are remarkably free from infective microbes, and the natural inference that the wound inflicted by them would be likely to heal kindly if protected from subsequent infection, has been confirmed by experience. It is no longer deemed essential that a bullet should be removed from a wound in order to avoid suppuration; the necessity for its removal arises from other conditions, such as its mechanical interference with the integrity or the function of important structures. This principle, which has been amply demonstrated in respect of other tissues and organs, has also been proved for bullet-wounds of the vertebral column, and even when the bullet has penetrated to the spinal canal. In a case under my care at the Chambers Street Hospital in 1890, the patient survived the injury a week, and died apparently of causes not connected with the wound; the autopsy showed the bullet lodged within the spinal canal at the twelfth dorsal vertebra, but without perforation of the dura, and its track showed only the evidence of advancing repair. The first impact of the bullet had caused a temporary paraplegia, which had disappeared by the second day.

In respect to the propriety of operative interference, the statement of Dr. Lidell that "the operation of resection or trephining the vertebræ is unjustifiable, because it does not offer a reasonable prospect of improving the patient's condition in any case, while, on the other hand, there is always reason to fear that it may increase the chances of a fatal termination," is certainly too sweeping; not only have several patients recovered after such interference, under circumstances which indicated that the operation had favorably influenced the course of the case, but the experience of the last few years in the operative surgery of the spine has shown that the removal of considerable portions of a vertebra, and even of several adjoining vertebræ, may be effected with safety if proper precautions are taken to secure and maintain surgical cleanliness of the wound.

The plan of treatment that now seems best for these rare injuries is simple disinfection of the wound by irrigation, in recent cases without important nerve-symptoms, and the use of a protective dressing in the

[1] Revue de Chirurgie, Février, 1892.

hope of obtaining primary union. That failing, or in cases in which there is reason to think that the bullet or fragments of the vertebræ have lodged in the spinal canal and are pressing upon the cord, the wound should be freely enlarged to give ready access to the bone and permit the removal of such fragments or of the bullet if present. Such treatment may not lead to the repair of a divided or crushed cord, but it may save one that has only been compressed from permanent degeneration, and it will diminish the risks incident to the period of repair.

Concussion of the Spine, and Remote Effects of Spinal Injuries —"Railway Spine."

As was stated in the note added by the editor to Dr. Lidell's article in Vol. IV., that article was written before the publication of Mr. Page's important book upon the same subjects, and consequently before the marked change in current professional opinion concerning them which followed that publication. The reaction from Mr. Erichsen's extreme views, which was anticipated from the beginning by many who appreciated the speculative character of the basis upon which they rested, has gone on to an almost total overthrow, and has practically removed the subject from the domain of the surgeon to that of the neurologist. Among the earliest of those who suggested the hysterical or neurasthenic character of the symptoms attributed to structural injuries of the cord, may be mentioned Drs. Putnam and Walton, who published papers in the Boston Medical and Surgical Journal and in the Archives of Medicine, in 1883. Of the work done by surgeons, by far the most important is to be found in Page's book already mentioned, and in Thorburn's "Contribution to the Surgery of the Spinal Cord," published in 1889. Of late many neurologists have studied the subject, with more or less detail and with more or less difference of opinion—Charcot, Oppenheim, Thomsen, Klein, Brissaud, and Grasset. Those who are interested in the subject will find a full bibliography up to date in Thorburn's book, and some later references in the writings of Charcot[1] and Brissaud.[2]

The belief in the alleged nosological entity termed "concussion of the spinal cord" appears to have little or no other support than an argument by analogy from "concussion of the brain," and on examination it is evident that the analogy is not close. It is now very generally held that in concussion of the brain there are recognizable structural lesions which may properly be regarded as slight forms of contusion, lesions consisting mainly in rupture of small vessels, with consequent extravasation of blood, and apparently produced sudden movement of the cerebro-spinal liquid occasioned by abrupt temporary change in the shape of the skull, or by shifting of the cerebral mass within it.

The physical conditions which favor the production of such lesions in such a manner within the skull, are not found in the spine. The cord is much more perfectly protected than the brain against movements within its bony case, and the waves of the liquid within the skull have no counterpart within the spine. In cases of extreme violence to the skull and brain, the wave has sometimes been traced down the central

[1] Œuvres, tome iii., 1890. [2] Gaz. des Hôpitaux, 23 Nov., 1889.

canal of the cord, but such an effect is only a relatively unimportant addition to the cerebral lesions.

The slighter lesions found in the cord after injury of the spine are probably the effect of direct pressure by a temporarily displaced vertebra (contusion), or of forcible elongation of the cord during a momentary diastasis of the corresponding portion of the spine.

In Mr. Page's summary of his analysis of cases of alleged concussion,[1] he says:

"We have thus been able to bring together a considerable number of cases of so-called concussion-injury of the spinal cord, and among them we have seen how few there are in which there has not been damage likewise to the spinal column. . . . We have endeavored upon anatomical grounds to show that the spinal cord shares but little of the risk of the brain to suffer lesion from blows directly inflicted upon its bony covering; and we have appealed to the unwritten experience of surgeons as to the rarity of lesions of the spinal cord in the absence of injury to the form, structure, and integrity of the spinal column. . . . And this fact is very prominent, that there is no evidence to show that the spinal cord can receive concussion-injury without the manifestation of undoubted symptoms, or that the cord itself can meet with structural traumatic lesion without the appearance of those symptoms immediately upon the injury."

As the result of such study and of such advance in our knowledge of the subject, it is not singular that the theory that the spinal cord is peculiarly liable to injury in railway accidents has ceased to be regarded with favor. The "railway-spine" of Mr. Erichsen had a brilliant but brief career, and soon gave place to the "railway brain," because the symptoms marking the condition were in the main cerebral, not spinal. But as Mr. Thorburn says, this change is but one step toward the truth; we still need more knowledge of the conditions grouped under that term. Study of the subject has tended steadily to bring the cases into the class of functional disturbances of the nervous system, neuroses or psychoses, and authors now use the terms "traumatic neurasthenia," "traumatic hysteria," "traumatic neuroses," and "traumatic neuropsychoses." The paralysis, the anæsthesia, the limitation of the field of vision, the long and varied group of symptoms formerly thought to indicate chronic inflammatory changes in the spinal meninges or in the cord, are now seen to be identical in character and behavior with the similar symptoms observed in cases of undoubted hysteria, and Charcot has shown that similar conditions can be produced by suggestion during hypnotic sleep. This latter fact has suggested an explanation of some of the symptoms on the theory of "auto-suggestion."

The symptoms vary greatly in degree, character, and duration. Mr. Thorburn groups them as those of acute and chronic hysteria. In the first he places those explosive "hysterical" manifestations with which all are familiar—screaming, crying, laughter—which soon pass away and leave no trace; also a second form, a condition of temporary oblivion in which the patient is not unconscious in the usual sense of the term, walks and talks, but remembers nothing of what he has said or done. Mr. Thorburn compares it to somnambulism. Such persons, too, often have extraordinary ideas as to what occurred at the time of the accident, and give circumstantial accounts of purely imaginary occur-

[1] Injuries of the Spine and Spinal Cord, etc., p. 49.

rences. The symptoms of the chronic form (following Thorburn) may be: (1) psychical, including epileptiform attacks and hysterical insanity, (2) motor, including paralysis and contractures of the limbs, and special effects upon such organs as the larynx and the bladder; (3) sensory anæsthesia, hyperæsthesia, and paræsthesia of the general or special sensory nerves; and (4) vasomotor, secretory, and trophic changes. In most cases there are also symptoms which are rather to be regarded as the effects of combined neurasthenia.

With reference to the prognosis, Thorburn says that if there is no pecuniary complication, that is, if the patient has no claim for damages because of the accident, and if proper treatment is promptly instituted, complete recovery within a few weeks may be confidently expected; if, in the same absence of pecuniary complications, treatment has been delayed, recovery will require more time. If, on the other hand, the patient has a claim for compensation, the symptoms will be markedly aggravated and recovery will be delayed until after the settlement of the claim; everything, in such a case, tends to fix the idea and to rivet the suggestion on a mind weakened by the worry of legal proceedings, and by the fear of the popularly accepted fate of the victim of "railway spine."

In the male the symptoms appear to be more fixed than in the female. A neurotic tendency, hereditary or acquired, and chronic alcoholism make the prognosis worse. Marked fluctuation in the symptoms, in degree or place, is highly favorable.

The indications for treatment are to improve the general condition and diminish the neurasthenic prostration, and as far as possible to avoid all that tends to fix the morbid ideas. Separation from friends and relatives is advisable, cold bathing, over-feeding, massage and faradism of the paralyzed parts. The bromides are to be avoided, because of their tendency to increase the neurasthenia. It is said that good results have been obtained by hypnotism.

DISEASES OF THE SPINE.

BY

DE FOREST WILLARD, M.D.,

CLINICAL PROFESSOR OF ORTHOPÆDIC SURGERY IN THE HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA, SURGEON TO THE PRESBYTERIAN HOSPITAL, PHILADELPHIA.

SPINA BIFIDA.

IT would be an advantage if the old name of "spina bifida" could be dropped, and a term adopted which would more accurately describe the actual pathological condition, since the spine is not really bifid. The defect actually consists in the absence of a portion of the vertebral arch, with a protrusion of the contents of the canal, either meninges or cord. *Rachischisis posterior*, *Schistorachis* (cleft spine), or *Atelorachidia* (defective spine), would more correctly designate the condition. When the meninges alone protrude through the opening, the tumor is a *meningocele;* when the cord contents also emerge, it is a *myelomeningocele.* The terms *hydro-meningocele*, *myelo-cystocele*, etc., are also employed.

Spina bifida anterior occasionally occurs from a defective vertebral body. These tumors occurring in the pelvis may present themselves in the vagina or rectum, and have been operated upon with fatal results, as instanced by Doughty, Thomas, Emmet, and others.

Spina bifida occulta is caused by a defect in the lumbar region. The tumor is covered with skin and with an excessive growth of hair.[1]

Koch,[2] Dareste, Lebedev,[3] and others do not assign to hydrops as great an influence in the etiology of spina bifida as do earlier authors. Koch believes that the bony defect is rather due to the failure of separation between the cutaneous and medullary layers after the formation of the medullary canal. The consequent septum between the neural tube and the skin prevents the osseous and muscular tissues from uniting at the median line, thus permitting hernia of the contents.

The report of the London Clinical Society's Committee gives the proportion of cases in which the spinal cord enters the sac as sixty-three per cent, and while this may not be true as regards the cord, yet there is no doubt that nerve elements enter the sac in even a much larger proportion of cases.

Thorburn reports a peculiar case of cicatrization of a spina bifida which compressed the cauda equina, producing anæsthesia and ulceration of the legs, while the walk was tabetic.

[1] Keating's Encyclop. Dis. Children, vol. iv., p. 733.
[2] Beiträge zur Lehre der Spina Bifida. [3] Virchow's Archiv, 13, Bd. lxxxvi., S. 263.

In a case now under my care, there is total loss of both motor and sensory power from below the line of the tumor in the lumbar region, and the trophic changes are so great that large bedsores almost constantly form beneath the buttocks and on the posterior parts of the thighs.

When the serous accumulation is contained in the dilated central cavity of the cord, the condition is known as *syringo-myelia* (σύριγξ, a tube, and μυελός, marrow), *hydromyelia*, or *hydrorachis interior*, a condition which is followed by a peculiar train of symptoms, recently closely studied and well described by Sinkler,[1] Lloyd,[2] and others. In only a few cases has the condition been diagnosed during life. Lloyd[3] has recently shown that injury of the cervical cord may produce similar symptoms in certain cases.

The principal symptoms are loss of power, muscular atrophy especially in the upper extremities, and loss of thermal sense together with great alterations in both tactile and pain sensation. When there is extreme loss of sensibility in the arms and marked trophic changes, the condition is known as Morvan's disease.

SYMPTOMS AND DIAGNOSIS OF SPINA BIFIDA.—The skin covering the tumor is at birth frequently in an unhealthy state of ulceration, but has a tendency to heal if friction is avoided. In well-formed cases there is no difficulty in diagnosis, but in cases where the communication with the canal has been severed, the differentiation from congenital cystic and other tumors will often be difficult. In several instances I have noted marked dimples and depressions over the sacrum, which were apparently the result of an incomplete but cured spinal defect. The depression so frequently found upon the tumor of spina bifida indicates either the point of attachment of the membranes or that of termination of the spinal cord. Tumors containing fœtal remains are sometimes found in a central dorsal position. Perforative ulcer is not infrequently associated with anæsthesia and paralysis.

TREATMENT OF SPINA BIFIDA.—As a protective measure I have found a wide pad of close-fitting leather most effective. An asbestos cloth which can be purified by fire when soiled with urine, lined with linen, is also advantageous. Gutta-percha and celluloid have also been used.

Paracentesis.—When tapping is performed the needle should be very small, and should enter the sac by a long route through healthy skin so as to prevent subsequent leakage and consequent infection. The utmost care must be exercised as to scrupulous cleanliness and asepsis. The puncture should be closed at once by iodoform collodion. Haley[4] holds that the continual leakage of cerebro-spinal fluid results in profound anæmia.

Injections.—Iodine injections are still in favor. The success of any form of treatment, whether injection, ligature, or excision, will depend largely upon the degree of communication which exists between the sac and the spinal cord, and secondly upon the elements contained in the sac. In pedunculated tumors, and in those of narrow base, an operation is much more hopeful than in sessile growths with large bony openings.

[1] International Clinics, Philadelphia, vol. iii., third series.
[2] Univ. Med. Magazine, 1892-3, vol. v., p. 393.
[3] Ibid., 1894.
[4] Journ. Amer. Med. Assoc., July, 1893.

Unfortunately, sessile spinal tumors are most common. The presence of the cord elements in the sac renders operative interference much more serious, and the resultant nervous symptoms are far more dangerous and fatal.

Whenever the inferior extremities are paralzyed, or poorly nourished, the existence of cord structures in the sac is almost certain, and operation then offers far less hope of success.

Morton's fluid is superior to Brainard's, as sterilized glycerin is less diffusible than water. Unfortunately, Morton's eighty per cent. of successful cases do not seem to be continued by the report of the London Clinical Society, which gives only fifty per cent; but even one-half of selected cases cured is not a bad showing for so serious a condition. It can be set down as a universal rule that successful operations are more liable to be reported than fatal ones. It should not be forgotten that speedy death has followed these injections. The most scrupulous cleanliness must be enforced, and leakage should be prevented, if necessary, by finger pressure for hours after the operation. This form of treatment is not hopeful in paraplegic cases. Contraction and solidification of the sac will warrant repetition of the injection.

Ligation, either with an elastic rubber cord, or with silk or catgut, is now but seldom practised, having been largely superseded by injection or excision. The use of the seton has been entirely discarded. Occasionally, but very rarely, a cure follows spontaneous rupture.[1]

Excision.—Within the past decade operative attempts having in view the removal of the sac and the closing of the abnormal opening in the bony canal have been renewed. These operations have been chiefly modifications of old plans, but have been rendered more hopeful in their results by strict attention to antiseptic precautions. These results, as indicated in an elaborate table made for me by Dr. John H. Rhein, show that of 103 patients with spina bifida operated upon by various methods of dissection and excision, 31 died, 63 were cured, and 9 improved; of these cases 48 were in the lumbar region, 14 in the sacro-lumbar, 31 in the sacral, 4 in the dorsal, and 6 in the cervical; 27 of the patients were operated upon in the first week of life, 42 in the first month, 64 within the first six months, and 75 within the first year. The operations under one week gave 9 deaths and 18 cures. One child was only two days old, and nine months afterward was reported as well, with no palsy; yet, it seems unjustifiable to submit so young a child to so serious an operation, especially when but little harm could result from delay.

The first reported operation which I have discovered was done by Sherwood, in 1811. The patient was six days old and recovered. In 13 operations reported in Hildebrand's clinic, 10 were for meningocele and 3 for myelocystocele. Three patients died from the operation and one subsequently. Ten were discharged cured; one was reported well twelve years afterward, and the remaining eight were living and well. Among these were two with myelocystocele. The third with myelocystocele lived three months, when the tumor recurred and the child also became hydrocephalic.[2] In cases accompanied by paraplegia, or when hydrocephalus exists, an operation is rarely of benefit.

[1] Knox, Lancet, 1894, vol. i., p. 472.

[2] Trans German Surg. Congress, 1893; Amer. Med.-Surg. Bulletin, June, 1893; Archiv f. klin. Chirurgie, Berlin, 1893, Bd. xlv., S. 200.

Since removal of the sac in severe cases necessitates removal of a portion of the cord, operative cases to be hopeful must be those in which the bony opening is small, and those in which there are but few cord elements. When the integumentary covering is thin and ulcerated it should be removed, and a flap of healthy skin from the loin should be turned inward to give a solid covering to the opening. This flap may be cut from good tissue and be turned upon its base as in ordinary plastic work. Recognizable cord structures and meninges may be replaced in the spinal canal, and the tissues sutured in separate layers and levels, so that the lines of union shall not be superimposed.

If the cauda equina, or other distinct nerve filaments, are found running across the sac after it is opened, they should be carefully dissected out (the incision running around the vasculo-medullary area) and should be replaced in the spinal canal. If the nerves run into the wall of the sac, this should be dissected free and replaced in the canal. In one of my cases the sac was cut away. The child did well for five days, when the temperature suddenly rose to 105° F., and he died in convulsions.

In a recent case in which I excised the sac, a tumor presented itself opposite the sacrum, and so much to the left of the median line that it appeared to be in the upper part of the buttock. This peculiarity of position was found on operation to have been due to the fact that the cleft was in the left laminal region, between the second and third segments, while the spinous processes were perfect; this carried the tumor decidedly out of its usual central position, and it protruded in the upper part of the left buttock. The tumor was covered with perfectly normal skin and with a thick layer of adipose tissue, the boy being over a year old. The neck of the sac was narrow, and a to-and-fro running stitch of catgut was put in before the sac was cut away. The stump was then sewn with an overhand stitch, such as is used in closing a uterine pedicle; this completely closed the opening. Recovery was uneventful. There was no leakage. There had been no paralysis, and no convulsions. At birth the tumor was very small, but enlarged whenever the child cried, and was steadily increasing in size.

Osteoplastic Operations.—The greatest advance in operative work is found in osteoplastic operations, in which attempt is made, by raising a bony flap around the margins of the opening, to secure an osseous closure. Parings can be made and the flaps united so as to form a solid bridge across the gap. In the sacral or lumbar regions a half-thickness of the innominate may be split off and turned into the gap, periosteum inward, without separating it from its ligamentous and muscular attachments, thus insuring its life. The transplantation of periosteum or of bone from other animals has been practised both experimentally and in the human subject by Jaksch, Barth, and others, the former transplanting bone from the head of a gosling with success. It is better to select a young animal rather than a fowl for the graft. A trephined button of bone from an animal has also been used, but the experiments of Wolff and others[1] show that while detached pieces of bone almost invariably die by transplantation, yet if they have the support of the muscles and fascial tissue they will live. A flap taken from the body of a vertebra, or portions of the articular process, attached to the soft parts, may be employed. When bone chips

[1] German Surgical Congress, 1893; American Med.-Surgical Bulletin, June, 1893.

are introduced they become vitalized and frequently waken a process of connective-tissue growth. Osteoblasts grow directly into the old bone as the constituents of the dead bone are re-absorbed and gradually become converted into the new; this seems to take place either with or without periosteum.

SPINAL CARIES.

The term *antero-posterior curvature of the spine* is certainly defective, since a curve may have its convexity either forward or backward, and the title is just as applicable to lordosis as to kyphosis. The term *kyphosis* is applicable also to either abrupt bending of the spine or the long, even, backward curve which is commonly seen in rickets, rheumatism, and feeble spine. We can hardly speak of an "angular curvature," although the term is frequently used to indicate the abruptness of the deformity caused by loss of vertebral bone substance.

I cannot agree with Mr. Treves in his remarks in Vol. IV., in regard to the term *caries of the spine*, since the name is very accurately descriptive of the actual process which occurs in so large a proportion of cases that the few minor ones need not be considered. Even though the bone may be exempt and the caries confined (as is rarely the case) to the intervertebral fibro-cartilages, yet these cartilages are just as much a portion of the spine as are the vertebræ, and the process is still distinctly a caries.

Since the publication of Mr. Treves's article the continued advance in pathology and bacteriology has been so marked, as was then clearly outlined, that there is no longer any hesitancy in regard to the term *vertebral tuberculosis*, since in the large majority of cases the disease is a local tubercular affection.

The term "Pott's Disease," while honoring the name of an individual justly distinguished, is not descriptive of any pathological process. To attach the name of any one to a definite process is inadvisable. If, therefore, we use the term *caries of the spine*, and even if we add the term *tuberculous*, we shall in nearly every case be both pathologically and clinically accurate.

ETIOLOGY OF SPINAL CARIES.—In regard to the effect of heredity and the question of traumatism as factors in producing this condition, it still seems difficult for the ordinary practitioner to realize that local tuberculosis may exist without general evidence of the disease, or without any history of heredity. Local tuberculous processes are exceedingly common, and in the large majority of cases systemic infection does not take place. This process develops in the vertebræ with greater ease than in other parts of the body, the spongy nature of the bones and their rather complicated articulations favoring the invasion. Whether we term it tuberculous, strumous, or inflammatory, the tendency of this process is to degeneration rather than to organization.

The effect of injury as a causative agent, formerly the subject of much discussion, is now plain. It is evident that traumatism is most positively a cause of local tuberculosis from the fact that inflammation following upon injury destroys the resisting power of a particular region

against the inroads of the tubercle bacilli, the result being that the disease gains a foothold in the tissues. Phagocytosis is constantly active in the body, and thus the bacilli are ordinarily overpowered. The resisting power of tissues may also be destroyed by poor food, bad air, low fevers, exhaustive diseases, etc.; or the individual may inherit non-resisting cells. In earlier days, when the statement that a patient was tuberculous meant that he was afflicted with a necessarily fatal lung disease, opposition was more violent to the theory that traumatism was a potent factor in the production of the condition. With our more thorough present knowledge of the process involved in local tuberculosis, it is easy to understand that even a slight traumatism may be productive of evil results, and that any tissue with vitality lowered by inflammation readily becomes the prey of the invading bacillus. Spinal tuberculosis, therefore, may either be hereditary, or may be acquired in the manner above mentioned.

The existence of local tubercular bone disease is frequently overlooked by physicians, simply because they are unable to trace any previous history of tubercular disease in the parents of the individual. But for the frequent errors of this kind it would seem hardly necessary at this day to refer to the great frequency of local tuberculosis, or even to the enormous amount of both known and unintentional deception which is constantly practised in regard to hereditary diseases. Again, many patients say truly that they know of no tubercular disease, and yet it may exist to a very large degree.

When positive evidence of tubercular disease is present it should be recognized as such, no matter what the antecedents. There is no reason that the same rule should not hold good in regard to a group of symptoms positively indicative of local tuberculosis that is accepted in regard to local sarcoma, fibroma, lipoma, or any other disease.

The effect of heredity is easily explained. One individual is born with cells already tainted, and possessing but feeble resisting power against the inroads of the tubercle bacillus, and he quickly yields to a local or general infection; another individual enters the world with a limited amount of repelling force sufficient to ward off an attack until a local injury with its consequent inflammation lessens the defensive power in that particular region, and vertebral, joint, or other local degeneration occurs; a third maintains the fight until some depressing disease or non-hygienic surrounding lowers his powers of defense, when his tissues yield; while a fourth, with every cell especially fortified by ancestral and personal purity of habits and surroundings, successfully repulses every onslaught of the deadly foe even through traumatism, sickness, and filth.

The frequency of the existence of the tuberculous process is evidenced in the fact that its presence was demonstrated in sixty-six out of one hundred cadavers examined by Schlenker.[1]

The spine is affected in nearly twenty per cent of the cases of local tuberculosis. Taylor[2] in 845 cases of spinal caries found that scrofulous or tubercular disease could be distinctly traced in at least thirty-four per cent., and Gibney[3] says that he finds either an hereditary or an acquired diathesis in nearly every case.

[1] Archiv f. path. Anat., Phys., und klin. Med., Bd. cxxxiv., S. 145; Univ. Med. Mag., Dec., 1893, p. 208. [2] Lovett, Diseases of the Hip, p. 64. Boston, 1891.
[3] Gibney, New York Med. Jour., July, 1877.

Following the hyperæmia produced by traumatism[1] or by disease, infection occurs through the blood-vessel system; bacilli aggregate in the capillaries of the Haversian canals, endarteritis is set up, and in the centre appears a small grayish spot. Rarefying osteitis follows, the trabeculæ are absorbed, and fatty degeneration of the bone cells soon occurs, with the formation of embryonal or granulation tissue in which giant and epithelioid cells are readily found. The gray spots slowly become yellowish, and speedily caseate or break down into pus.

There is but little reason to doubt that this process is tuberculous, as it corresponds histologically with tuberculous changes in other regions. Inoculation experiments, such as those of Schiller, Parllovski[2] and others prove that bone tuberculosis and general tuberculosis are interchangeable. Bacteriologically it is not easy to demonstrate the presence of the tubercle bacillus,[3] as it is only found in a small proportion of cases,[4] but patient search by Ehrlicher's or other method will demonstrate its presence, and inoculation or culture tests will ordinarily establish the nature of the process.[5]

RARE FORMS OF SPINAL ABSCESS.—Abscesses from spinal caries in the dorsal region occasionally discharge into the pleural cavity and from thence into the lungs. I have seen several cures take place, even when pus has taken this route. The diagnosis between this process and lung tuberculosis is often difficult, unless the history and progress of the case are thoroughly considered.

I have in a number of instances seen abscesses opening into the bladder, rectum, or vagina. In another case a tumor diagnosed as "fatty" had formed just above the knee; careful palpation discovered induration extending up the thigh and into the pelvis. There was no deformity, but diligent inquiry revealed the existence of a "weak back" for nine years, and subsequent post-mortem examination disclosed a carious lumbar vertebra. I have also seen a pelvic accumulation of pus burst rapidly through the ischiatic foramen, when compressed anteriorly by the application of a plaster jacket.

PROCESS OF REPAIR AFTER SPINAL CARIES.—It is absolutely true that loss of tissue from vertebral tuberculosis is never thoroughly repaired; hence the resultant deformity will depend largely upon such loss of tissue. When once angulation has occurred, deformity is permanent; but of course if the spine is held rigidly straight from the inception of the disease, the amount of new tissue formed between the diseased bodies will be greater, and hence the deformity will be markedly less.

THE SPINAL DEFORMITY.—Lateral deviation may occur not only in the cervical region, as noted in Mr. Treves's article, but also in the dorsal and lumbar regions. It is due either to the unequal yielding of the sides of the bodies of the vertebræ, or to excessive muscular action of one side, or to muscular relaxation to relieve pain.

[1] Centralblatt f. Chir., 1878, Bd. v.; Lovett, op. cit., p. 60.
[2] Hueter; Archiv f. Chirurgie; 1879, Bd. xl., S. 317. Lovett, op. cit., p. 68.
[3] Park, Mütter Lectures on Surg. Pathology, p. 215. St. Louis, 1892.
[4] Kanzlen, Berlin. klin. Wochenschrift, 2 Jan., 1884, S. 14.
[5] Park, Med. Press of Western New York, Jan., 1887.

Lovett [1] has pointed out that it is an early symptom of spinal caries, largely due to muscular irritation, and advises that it should be looked upon as a diagnostic symptom. It differs widely from ordinary lateral curvature of the spine, from the fact that it is an abrupt tilting to one side, not a long rounded curve with rotation, as commonly seen in the latter condition; moreover, the symptoms of the diseases are usually entirely different.

DISTURBANCE OF THE MOTOR NERVOUS SYSTEM IN SPINAL CARIES.—*Paraplegia* is most common when the caries is situated in the dorsal region, since the cord at this point nearly fills the canal. Paralysis is usually produced, not by direct bone pressure from angulation, but by pachymeningitis with tuberculous or inflammatory deposit encroaching upon the cord. Cases of even right-angled deformity may escape, while those of slight deformity may be of severe grade, especially when the deposit is pressing upon the anterior column of the cord. This was well illustrated in one of my recent laminectomies, when there was found a tuberculous nodule upon the antero-lateral column, while in front of the cord was a large mass of tubercular tissue. Paraplegia had existed for more than a year. Lloyd [2] describes a section of cord from a case of paraplegia in which the patient died from septic infection due to bed-sores over the sacrum, the seventh dorsal vertebra having been previously diseased. He agrees, in common with Sinkler [3] and others,[4] that the deposit is nearly always the result of pachymeningitis or lepto-meningitis, and that if transverse myelitis results it is a later condition. Schwenkel gives the result of 52 post-mortem examinations, in 32 of which compression existed, and Karskel [5] gives 70 cases in which inflammatory or caseous products were present.

DIAGNOSIS OF SPINAL CARIES.—Lateral deviation in spinal caries is usually abrupt, and is widely different from the long arch of lateral curvature. An occasional error may be made at the first examination of a resisting, crying child, when apparent rigidity of the spine may be found, and yet the complaint may be really a lateral curvature. In young children with torticollis, several examinations are sometimes necessary to exclude the non-existence of caries of the spine, if there is no deformity and if the rigidity is slight. Rigidity is the most reliable sign of caries; but even rigidity requires to be differentiated from voluntary muscular resistance.

Suppurative spinal caries is not infrequently confused with hip disease. Open sinuses in the groin below Poupart's ligament, or behind the great trochanter, or at some other point in the thigh or in the buttock, frequently exist, together with marked rigidity at the hip. Flexion may also be present to the extent of 30 or 40 degrees, with resistance to motion in any direction at the hip, on account of pain, and from contraction of the irritated psoas muscle. Especially when no history is attainable, and without careful examination, or when the back is without deformity, the true condition may be overlooked, and the error may not be corrected until kyphosis subsequently appears. Very frequently

[1] Trans. Am. Orthopædic Assoc., vol. iii., p. 186.
[2] Univ. Med. Mag., Dec., 1893, p. 143.
[3] Med. News, Nov. 18, 1893.
[4] Elliot, New York Med. Journal, June 2, 1888.
[5] Schmidt's Jahrbücher, Leipzig, Apr., 1892.

also, both hip disease and spinal caries may be present from multiple tubercular foci. Deep palpation in the iliac fossæ will often reveal a deposit of pus even when there is but slight deformity of the spine.

TREATMENT OF SPINAL CARIES.—Treatment by prolonged recumbency yields such superior results that it is largely adopted by those who have tested its merits. It inflicts no pain upon the patient, it lessens deformity, and its irksomeness is largely mitigated by the use of a suitable bed frame, or tray, or stretcher, which permits the patient to live in the open air. This frame may be made of wood, or gas-pipe, flat iron, brass rods, or other metal. Canvas, linen, or other material is stretched across the frame. Defecation in young children can be readily managed. If the canvas is smooth and in one piece the child need not be removed from it, since the frame can be placed in any bed. The child, carried easily upon the tray, may be placed on supports in the open air, in a long baby coach, or upon a set of wheels, and may thus live out-of-doors nearly all the time. An awning may be erected over the carriage, and toys may be suspended at convenient places for the amusement even of an infant. A two-inch mattress placed upon such a stretcher in winter will protect the child from cold. When head or foot extension is desirable, the pulleys may be attached directly to the frame and extension maintained either by weight or by elastic bands. Counter-extension may be made by elevating one end of the stretcher. Cervical and upper dorsal cases necessarily require a long period of recumbency. Three months after the acute stage has passed the child may be fitted with an apparatus and permitted to move about.

Extension and Suspension.—Extension either in the horizontal or in the erect position has a most beneficial effect not only on the bones themselves but on the nutrition of the cord. Its employment in bed has already been described. In the sitting position it is best employed by fitting a strong, curved davit-arm to a chair,[1] from the projection of which above the head of the patient a pulley may be rigged to attach to a well-fitting head-piece.[2] The amount and the time of the extension must be regulated by the feelings of the patient. Additional extension from the armpits and thorax may be secured by shoulder-straps incorporated in a plaster jacket. Mitchell says that a patient will bear a pull of from twenty to seventy pounds for five or six hours a day.

Mechanical Appliances.—The immense variety of apparatus employed shows that the inherent difficulties are many. One class of appliances, represented by plaster, felt, leather, wood, aluminium and other metal jackets, attempts to secure fixation or limitation of motion in the vertebræ. This is accomplished much in the same manner as in the treatment of fractures by the application of an encircling splint. The support given to the ribs by the outside casing is also a factor in securing fixation. In young children with small pelves this method is very helpful, since a steel appliance readily slips down on the hips. In the application of a plaster jacket in painful cases it should not be forgotten that the most comfortable position for the patient is lying upon the abdomen in a narrow, plain muslin hammock, the muslin itself to be included in the turns of the plaster bandage as it is applied.

[1] Bradford and Lovett, Orthopædic Surgery, 1890, p. 70.
[2] Mitchell, Trans. Phila. College of Physicians, 1889, vol. xii., p. 82.

The best representative of a steel spinal support which acts upon the principle of antero-posterior leverage, is the Taylor brace with its various modifications.[1] It consists of two steel bars placed in the gutters on either side of the spinous processes, the bars following the pathological curves. At the upper end are two arms which pass over the shoulders at the root of the neck. Below, the uprights are secured to an inverted U-shaped frame, the lower pads of which are fitted into the post-trochanteric sulci on either side. To give anterior support to the shoulders, chest pieces are applied below the clavicle to the anterior portion of the thorax, being firmly secured to the posterior uprights. This posterior splint is firmly fastened in position by an anterior apron with straps passing round the body. Perineal straps also serve to fix the apparatus. The uprights are hinged to permit of motion backward but not forward.[2] Whitman[3] describes a modification of this form of apparatus, which even more thoroughly fixes and rigidly holds the shoulders.

Another class of appliances is represented by the lateral crutch, which is expected to maintain the erect position, not with the expectation of relieving the spinal column of its superabundant weight, but by supporting the shoulders and thus preventing the bending forward of the body. Still another class of apparatus, represented by Stillman's, attempts by spring or elastic force to straighten the existing kyphosis.

No one form of apparatus is sufficient for all cases, and adaptations must be made for each particular patient. As a rule the encasing apparatus is the most comfortable and permits of the least motion of the the diseased vertebræ. Plaster of Paris is the cheapest and gives the most support, but has the disadvantage of weight. The objections to non-removable jackets are avoided by cutting open the plaster jacket along its front and having it bound and laced. Wood and paper jackets[4] are serviceable, but aluminium[5] will doubtless come into use when its alloys are better known. The objections which have been urged against the use of the partially tanned leather jacket recommended by Agnew, and largely used in America, have arisen from a want of practical acquaintance with it. Taking a plaster cast does not require long suspension, seldom more than a few minutes, and the patient is quickly placed in a recumbent posture, after which the cast is at once cut open and removed. When made of proper leather and well fitted over a mould, Agnew's apparatus is a most satisfactory and comfortable support, and yields excellent results. The leather is only partially tanned, and is stiffened at a few points by steel strips.[6]

The use of *poro-plastic* felt, even in the temperate climate of America, is unsatisfactory, as the heat of the body soon softens and renders it useless.

When the location of caries is above the seventh dorsal vertebra, any form of encircling splint becomes more and more ineffective as a

[1] This is thoroughly described in the Transactions of the American Orthopædic Association, vol. i., 1889, p. 15.

[2] See illustration in Trans. Am. Orthop. Assoc., vol. i., p. 15.

[3] Trans. Am. Orthop. Assoc., vol. v., p. 44.

[4] Young, Orthop. Surgery, pp. 45–49, Phila., 1894; also Annals of Gynæcology and Pædiatry, August, 1891.

[5] Phelps, Transactions of the American Orthopædic Association, 1893.

[6] Agnew, Principles and Practice of Surgery, 2d edition, Philadelphia, 1889, vol. ii., p. 881

higher level is reached, and a head support is needed to restrict the movements of the upper portion of the spine. This head fixation may be accomplished by the jury-mast attachment (Sayre[1]); or by chin cup and occipital plate (Taylor[2]); or by a prolongation to the vertex of the posterior bars,[3] properly curved, with forehead and chin straps; or by postero-lateral U-shaped supports.[4]

OPERATIVE MEASURES FOR SPINAL CARIES.—*Treatment of Abscess by Aspiration and Injection.*—While antiseptic measures render the opening of a spinal abscess a perfectly safe procedure, yet unfortunately the results obtained by operation are not brilliant, since it is seldom possible to remove all sources of suppuration. Abscesses that are small require injections of iodoform, 10 per cent., in boiled olive oil or in glycerin. One drachm or more may be permitted to remain after the contents have been drained off. This process may be repeated in two weeks. The procedure not only permits the inhibitory action of iodoform upon the tubercle bacilli, but it also strengthens and thickens the walls of the sac so that systemic infection is less likely to occur when an opening is made. This procedure will frequently prevent the formation of abscess when only the liquefaction of caseation is present in the sac; caseation, absorption, or encapsulation subsequently taking place, and a permanent cure resulting, provided traumatism does not reawaken the focus. Mechanical fixation is always to be associated with any form of treatment.

Drainage.—When the sero-purulent material reaccumulates, or when pus is evident, an incision should be made, after very careful cleansing of the patient, and with strict precautions against the entrance of infection. The pus should be thoroughly washed out with hot boracic acid or bichloride solution in order to destroy the bacilli. No pressure should be made upon the walls of the abscess lest a fissure should ensue and infection of the system should occur. When an abscess wall can be thoroughly curetted or excised, injections with iodoform-oil may be used and immediate closure practised.

When the abscess wall cannot be excised or curetted, then it is advisable to make a counter opening either in the loin or through the os innominatum, by trephining or by notching the edge of the bone, and to institute through-and-through drainage, after which washing with corrosive sublimate or with peroxide of hydrogen, and the employment of iodoform-oil injections together with strict antiseptic dressings, will usually greatly shorten the suppurative process.

At a discussion on Spinal Caries at the American Orthopædic Association,[5] the conclusion reached was that operative treatment of abscess, while not materially affecting the course of the disease, yet, when properly combined with thorough and prolonged mechanical fixation of the diseased area, tended to shorten the period of cure, and to lower the destructive temperature of confined purulent accumulations.[6]

Erasion of the Vertebræ.—When it is possible to reach the diseased portions of the vertebræ in the lumbar region, erasion should be attempted,

[1] Bradford and Lovett, Orthopædic Surgery, 1890, p. 59.
[2] Ibid., p. 79. [3] Ibid., p. 82.
[4] Davis, Trans. College of Physicians, Philadelphia, 1891, vol. xiii., p. 123.
[5] Trans. Amer. Ortho. Assoc., 1891.
[6] Townsend, Phila. Med. News, 1891; Trans. Am. Orthopædic Assoc., 1891.

although it is still a problem whether the entire process of separation of carious bone is hastened by this procedure, as the curette necessarily destroys a superficial layer of bone cells. Chipault[1] gives the history of the attempts made by Treves, Lannelongue, Reclus, and others for the removal of carious bone, and concludes that it is possible to curette the body of a vertebra even in front of the cord.[2]

The incision should be outside the border of the erector spinæ muscle, say two and one-half inches from the median line, until the transversalis fascia is reached, when this membrane should be followed to the transverse process. The attachments to the transverse process must be removed, and the quadratus separated from the psoas. The abdominal branches of the lumbar arteries may be followed. Removing the transverse process by rongeur forceps the front of the vertebral body can be reached, and the diseased area should then be thoroughly curetted. After this the diseased surface should be mopped with pure carbolic acid to prevent absorption of septic material, and the parts thoroughly drained. Unfortunately it is not possible to determine whether the entire extent of caries is reached; hence, while the process of suppuration may be shortened, it may not be entirely prevented.

Shimwell[3] advises an incision from the middle of Poupart's ligament, curved upward nearly to the ribs, with the convexity outward. When the transverse fascia is reached its layers are separated until the promontory of the sacrum is exposed. Another incision is made on the outer side of the erector spinæ down to the posterior leaflet of the transversalis fascia, having passed through which it is easy to work back to the body of the vertebra. Through these openings the body may be readily examined, curetted, and drained.

In the dorsal region the operation becomes more difficult, since the articulating processes and the heads and necks of the ribs must be removed in order to reach the anterior part of the vertebræ.

Vincent[4] reports that he has been able not only to remove the carious body of the vertebra after resection of the ribs, but also to carry a drainage tube in front of the cord. I have been able to accomplish this in one instance where the body had been largely eroded and its place occupied by a large caseous cavity, but in all other cases, and in some twenty-five experiments upon living dogs, I have not been able to reach the front of the vertebral body without opening the pleura, which lies in close proximity to the articular process. It is scarcely possible to avoid this accident unless the pleura has been pushed forward by the disease.

The articular processes and the ribs are to be resected subperiosteally. The intercostal muscles are to be separated, the pleura detached, and the fungosity followed to the site of flexion of the spinal column, or within the premedullary triangle caused by the destruction of the vertebral bodies. An incision upon the opposite side and the use of a long probe will permit the passage of a drainage tube through the caseating or suppurating mass which occupies the original position of the body of the vertebra. By this method thorough drainage is secured, and iodoform or other local remedies may be introduced.

Vincent also practises lateral trephining of the body of even a

[1] Revue de Chirurgie, 7 Nov., 1891.
[2] Chipault, Dublin Med. Journal, June 1, 1892.
[3] Med. News, Oct. 21, 1893.
[4] Revue de Chirurgie, 1892-93, p. 273.

dorsal vertebra, a "trans-somatique" operation, with curetting and drainage, after resecting the head of the rib.

Chipault has proposed to trephine or gnaw away the lamina, and then carry a drainage tube across the canal to the body of the bone. This procedure exposes the cord to danger from septic infection and is not justifiable. It is seldom possible to remove the diseased bone, and free drainage seems to be the only benefit to be derived from this operation.

Schaeffer[1] advises reaching the vertebral bodies behind the psoas muscle in the lumbar region, and in the dorsal region resects the transverse processes and heads of the ribs.

The risk of infecting the pleural cavity with tubercular material is certainly a matter for grave consideration.

LAMNECTOMY, FORMERLY CALLED TREPHINING OF THE SPINE.—Removal of the laminæ for the relief of pressure paraplegia has become an established operation in spinal caries since Macewen published his successful series of cases,[2] although it is limited in its beneficial results. The majority of cases of paraplegia yield to long-continued extension, rest, and fixation of the spine, but when the carious process is limited to the posterior arches of the vertebræ the operation is undoubtedly indicated. In cases of exaggerated reflex, ankle clonus, etc., where paraplegia has persisted in spite of treatment, it is a procedure to be recommended in a limited number of cases.

Lane[3] speaks most hopefully of the results; but in my experience[4] it is an operation accompanied with great shock.

An incision is made a little to one side of the spinous processes. The arches are cleared from muscular tissue. During this stage of the operation free venous hemorrhage may be expected, but it may usually be controlled by the use of hot water and packing. In the dorsal region the cord is comparatively accessible, but in the lumbar region, in muscular subjects, the operation is a tedious and difficult procedure.

Abbe separates the muscles on one side only, and by cutting off the spinous processes at their bases permits them to slip over in a block. The ligamentum subflavum first appears in view, and may easily be mistaken for the cord, but the error is soon corrected. Removal of the first lamina is the most troublesome part of the operation. It is best gnawed through with sharp rongeur forceps, or divided with a saw.

After the removal of the first arch, the others may easily be taken away with rongeur forceps with flat lower blade. The base of the lower blade must be narrow so as not to become wedged. These forceps as modified by Hopkins and Keen are very serviceable.[5]

Frequently tuberculous deposits will be found pressing upon the cord, or there may be pus or other inflammatory deposit from pachymeningitis, all of which should be removed as thoroughly as possible.

[1] Trans. Illinois State Med. Soc., 1891.

[2] Brit. Med. Journ., 1888, vol. ii., p. 1308; Glasgow Med. Jour., 1884, vol. xxii., p. 55; Ibid., 1885–86, vol. xxv., p. 210; Ibid., 1888, p. 11; Brit. Med. Journ., Aug. 11, 1888; Lancet, July 14, 1888.

[3] Brit. Med. Journ., 1891, vol. ii., p. 949; Ibid., 1892, vol. ii., p. 1495; Ibid., 1889, and June 6, 1892; Ibid., Oct. 31, 1892; Trans. Clinical Society, London, 1892, vol. xxv., p. 30; Archives of Pædiatrics, March, 1893, p. 285.

[4] Trans. College Physicians, Philadelphia, 1891; Mütter Lectures, 1893.

[5] Buck's Reference Handbook of the Medical Sciences, vol. ix., p. 824, Fig. 591.

When the extra-dural tuberculous deposit is large in amount, it is better not to open the membrane lest infection ensue.

With a curved probe the anterior region of the cord may be explored, and by sacrificing one spinal root it is possible even to remove the anterior deposits. Manipulation of the cord should be carefully avoided, as it adds markedly to the shock of operation. Bone fragments, if found, may be removed.

Hot boracic acid solution should be used for washing, and drainage should be thorough, both by rubber tubing and catgut. The muscles above and below should be sutured in separate layers, and the wound should be packed with iodoform or aristol gauze.

In cases where the posterior arches are the seat of caries, as in cases reported by Dr. John B. Roberts [1] and by myself,[2] considerable portions of the bone may be removed, but, unfortunately, complete removal is seldom possible, as the disease commonly extends to the bodies.

Urban [3] lifts a large mass of muscle with the laminæ, and replaces the trap-door flap; Chipault and Vincent,[4] and Israel [5] are in favor of very radical and complete removal, not only of the deposit, but of the diseased bone in front of the canal.

Lane [6] and Horsley [7] are favorable to early operative interference; but Thorburn [8] declares that we do not lose by waiting.

A study of the literature of lamnectomy shows that, save the two attempts of Maisonneuve in 1860, there were no operations of this character until about fifteen years ago, when Lannelongue removed the detached spine of the second dorsal, an operation which should more properly be classed under the head of removal of carious bone. Jackson's operation in 1882 was probably the first deliberately planned attempt to remove pressure and relieve the paraplegia. Temporary improvement is frequently noted immediately after the operation, undoubtedly from the relief of pressure, but as the tubercular and inflammatory deposits reform, relapses are frequent and death has followed in a number of instances.

In 134 recorded cases (or 130, omitting 4 that are incomplete in detail), the total deaths within a year after the operation were 58, making a percentage of 44.6. Thirty-two patients died of shock, or within the first week, and their deaths may be fairly attributed to the operation, 24.6 per cent. Forty-seven, or 36 per cent., died within the first month; and the lives of all these may be said to have been shortened by the surgical interference.

Of the 75 cases in which the patients survived, 11 are recorded as "unsuccessful," or "not improved," and 15 more as only "slightly improved," while only 46 cases can really be set down as decidedly and permanently benefited, a percentage of 35.4.

It is of course impossible to judge of the possibilities of these forty-six cases had they been treated by rest and extension, but the results of lamnectomy are certainly far from satisfactory, and prove that

[1] Trans. Phila. Co. Med. Soc., 1893.
[2] Mütter Lectures, College of Physicians, Phila., 1893-94.
[3] Verhand. d. Deutsch. Gesellsch. f. Chirurg., 1892, No. 21.
[4] Revue de Chirurgie, 1892-93, p. 273.
[5] Verhand. d. Deutsch. Gesellsch. f. Chirurgie, 1892, No. 21, Bd. ii., S. 211.
[6] Trans. Clin. Soc., London, 1892, vol. xxv., p. 30; Brit. Med. Journal, 1891.
[7] Brit. Med. Journal, 1890, vol. ii., p. 1286.
[8] Surgery of the Spinal Cord, p. 800. 1891.

thorough hygienic, mechanical, and fixation methods should be instituted for a long time before operative interference is attempted, since it is a well-known fact that a large proportion of patients with pressure paraplegia recover. It is to be presumed, however, that these cases were of the most helpless class, and that all other means had been exhausted without benefit.

As far as recorded, 70 of these cases were in males and 35 in females, while the respective numbers of children and adults were 75 and 43. The dorsal region was the seat of disease in ninety-eight cases, the cervical in twelve, and the lumbar in six.

WIRING OF THE SPINOUS PROCESSES.—Hadra[1] has proposed to wire together the spinous processes of the diseased vertebræ, thus preventing the approximation of the anterior portions of the column, and compelling Nature to bridge the chasm. He gives no cases in which this operation has been practised, but simply suggests it. Wilkins[2] has modified this plan by passing a figure-of-eight wire suture through the intervertebral foramina.

PUNCTURE OF THE SPINAL CANAL.—Wynter[3] and Quincke advise puncture of the canal to relieve pressure in cases of tubercular meningitis. The trunk being flexed, a small trocar may be driven into the space between the second and third lumbar arches. Sahl and Naunyn[4] have also performed the operation a number of times.

CONGENITAL SACRO-COCCYGEAL TUMORS.

Mr. Treves's article in Vol. IV. leaves but little to be said of these tumors. In the majority of cases complete excision and non-interference are the only methods of treatment to be employed. Borges successfully removed a congenital lipoma from the meninges in the lumbo-sacral region of a child eight years old. The only similar case is reported by Johnson.

LORDOSIS.

The most common causes of lordosis are rickets and infantile paralysis, with the resultant deformity of the lower limbs and atrophy of the muscles in the latter disease. Curvature of the spine and extreme lordosis are not uncommon, especially in the contractions of the rectus and tensor vaginæ femoris, with secondary shortening of the psoas and iliacus. This condition, if of long standing, can only be relieved, after myotomy of the contracted muscles, by long-continued extension in bed.

[1] Trans. Am. Orthop. Asso., 1891, p. 206.
[2] St. Louis Med. and Surg. Jour., 1888, p. 341. [3] Lancet, 1891.
[4] Univ. Med. Mag., Aug., 1893; Wiener med. Presse, No. xix., 1893.

INJURIES AND DISEASES OF THE EYE.

BY

CHARLES W. KOLLOCK, M.D.,

LECTURER ON DISEASES OF THE EYE AND EAR IN THE CHARLESTON MEDICAL SCHOOL AND OPHTHALMIC SURGEON TO THE CHARLESTON CITY HOSPITAL AND SHIRRAS DISPENSARY, CHARLESTON, SOUTH CAROLINA.

ANÆSTHETICS IN EYE SURGERY.

THE discovery of the property which *cocaine* possesses of causing local anæsthesia, and of the wonderful effects produced by the practice of asepsis and antisepsis, have given ophthalmology an impetus that has kept it abreast of all the special branches of medicine, and allowed it to be surpassed by none. *Ether* and *chloroform* are rarely used in ophthalmic practice except in the performance of operations that require considerable time, for enucleation and evisceration, resection of the optic nerve, and in cases of children who on account of their nervous temperaments fear any kind of operation. *Bromide of ethyl*, which has long been known as an anæsthetic suitable for operations that require but a short time, has of late come more into notice, and is now being used for such operations as enucleation and strabotomy. *Tropacocaine* is a substitute for cocaine, but as yet is rather too expensive for general use, especially as cocaine fills almost every want. Anæsthesia by tropacocaine is said to last longer and to be more readily produced upon inflamed surfaces than that caused by cocaine. It may be employed in solutions of two per cent. for ordinary purposes, and of five per cent. for deep-seated operations. It has no hæmostatic or mydriatic effect (Ferdinand).

ASEPSIS AND ANTISEPSIS IN EYE SURGERY.

In the treatment of all ocular diseases and in the performance of all operations, absolute cleanliness should be the first rule learned and carried out. Boiled distilled water should be used for making all solutions, and the antiseptics employed should be those possessing the strongest germicidal and the least irritating effects. It is scarcely safe to use bichloride of mercury for the conjunctiva in solutions stronger than 1 in 8000 or 1 in 10,000, for severe conjunctivitis has been produced by a solution of 1 in 5000 parts. For cleansing the parts surrounding the eye, solutions of 1 in 2000 or 1 in 3000 may be employed without fear. Solutions of bichloride of mercury are of course not suita-

ble for instruments, but cyanide of mercury (Chibret), from 1 in 200 to 1 in 1500, may be used for cleansing both the instruments and the surface of the patient. Bourgeoise recommends boric acid in an aqueous solution of borax. After an operation has been commenced, there is perhaps no better preparation for cleansing than a four-per-cent. solution of boric acid freshly made in boiling water. It is necessary that the water should boil after the acid has been added in order that any impurity contained in the latter shall be destroyed by the heat. Nuel also recommends the physiological salt solution for the same purposes. According to G. E. and A. E. de Schweinitz the solutions of boric acid and cocaine contain many poisonous germs when not fresh, and it is therefore necessary that care should be exercised, for these preparations are perhaps more constantly employed in diseases and operations than any others. For the same reason pipettes, cotton, gauze, and bandages should be thoroughly sterilized.

For sterilizing instruments boiling water is probably the most effective, simple, and easily obtained material. They may also be placed in a bath of cyanide of mercury (1 in 1500), in absolute alcohol, or in a saturated solution of boric acid after they have been sterilized. Dressings may be sterilized by steam, or may be dipped in strong solutions of bichloride of mercury. Iodoform and aristol, which have been highly recommended, are less suitable for the conjunctiva, which they irritate by acting as foreign bodies; but they may be used with advantage by dusting over the lids and along the commissure.

Diseased conditions of the lids and lachrymal apparatus should be cured before any operations are performed on the ball. When there is disease of the lachrymal sac it has been advised (Haab) to occlude the canaliculi by cauterization.

Injuries of the Eyeball.

Foreign Bodies in the Eye.—In no operation on the eye are the effects of cocaine more useful and more appreciated by both patient and surgeon than in removing foreign bodies. A few drops of a four-per-cent. solution soon quiets the most irritable eye, so that it may be handled with impunity and without pain. Minute particles are at times overlooked by the most careful operator, and in order that there may be no doubt as to the presence of a foreign body, a drop or two of a solution of fluorescine may be dropped into the eye. When there is a break in the epithelium of the cornea the spot immediately becomes green, and if a foreign body is present it is surrounded by the green spot.

Foreign bodies that penetrate the eye require prompt attention. When lodged in the cornea they should be removed through the point of entrance. Bodies that have penetrated the cornea and entered the anterior chamber should be removed at the most convenient point that will interfere least with vision. No exact rules can be laid down for their removal, but generally a peripheral opening should be made with a lance or Graefe knife, and if the body can be grasped by a small forceps this will be the readiest instrument; but when it is difficult to seize, it may (if steel or iron) be brought to the opening by the electro-magnet,

and then withdrawn by forceps. Bodies that have lodged in the iris are very difficult to remove without excising a portion of that membrane. When bleeding follows the iridectomy, removal may be complicated by the introduction of the magnet, which at times coagulates the blood.

Foreign bodies that have penetrated the lens are very difficult to handle. When they have but partially penetrated, and project also into the anterior chamber, no effort should be spared for their removal, and the greatest care should be exercised in order that the lens should be disturbed as little as possible, for though these injuries are generally followed by the formation of cataract, still, in a small number of recorded cases, the resulting opacities have either cleared or have not increased. Bodies that have passed wholly into the lens substance usually cause rapid loss of vision, but in rare instances have remained in the lens for a considerable time without producing general opacity. It is at times difficult to decide how such cases shall be treated. The removal of a traumatic cataract, when vision in the other eye is good, has little to recommend it beyond the cosmetic effect. Usually foreign bodies are found at the bottom of the capsule (unless recently introduced), and move with every motion of the eye.

Evacuation of the lens-substance does not insure removal of the foreign body, and should it by any accident escape into the vitreous, the condition would be far worse than before. Therefore, unless it is solidly imbedded in the lens substance and can be extracted with it, or can be taken out in the capsule, it is far better to allow it to remain undisturbed.

Foreign Bodies in the Vitreous.—The electro-magnet has worked wonders among these cases, and many eyes are now saved for good and useful vision that were formerly either removed at once or left only to become blind. When possible, the foreign body should be located by the aid of the ophthalmoscope, but when this is impossible then the general direction of its course, its probable size, and its velocity must be taken into consideration. When the case is seen soon after the accident, the point of the magnet may be introduced through the opening made by the foreign body; but if important tissues are likely to be injured by this proceeding, another opening may be made close to its position as well as this can be determined, and where there is least likelihood of doing permanent injury. When the exact position of the foreign body is unknown, the opening may be made through the conjunctiva and sclera, about the equator, and near the lower edge of the external rectus muscle. For this purpose a Graefe knife may be used, and care must be taken that the opening in the conjunctiva is not directly over that in the sclera. The opening should be large enough for the easy withdrawal of the foreign body when its size can be approximately determined. The point of the magnet is gently introduced and held for a short time just within the globe, so that if the foreign body is near it may be attracted without further disturbance of the vitreous; but should this fail, the point is carefully moved in different directions until the foreign body is found, or until it is demonstrated that the magnet is useless.

The failure to remove these bodies with the magnet is generally caused by their having become encapsulated, or by their having

passed through into the orbit; but it is not safe to depend upon the latter supposition, and the injured eye should be enucleated, unless vision is still good, when it should be kept under strict surveillance. Perfect cleanliness must be observed in all operations for the removal of foreign bodies from any portion of the eye, and the suggestions under the head of asepsis and antisepsis should be carefully followed. The conjunctival wound, if large, may be closed with aseptic sutures, and the eye should then be protected by a light dressing.

WOUNDS OF THE EYEBALL.—But little need be said in addition to what is contained in the article of Dr. Williams, except perhaps as to the manner of treatment. Perfect cleanliness of wounds and of surrounding parts has done much toward saving many eyes that were thought to be irreparably injured. Sutures are rarely necessary except in wounds involving the conjunctiva and sclera, and then only in the former. The danger of infection is always greater when the vitreous chamber is opened, and the greatest care should be taken in cleansing such wounds and thoroughly disinfecting them. Before closing the wound a few drops of a solution of bichloride of mercury (1 in 1000) may be instilled.

INJURIES AND DISEASES OF THE EYELIDS.

SYMBLEPHARON.—In addition to the methods by sliding flaps of conjunctiva which have long been practised in the treatment of symblepharon, the methods of Harlan and Hotz are often of use when there is extensive attachment between the lid and ball. Harlan's operation is especially useful when the entire lower lid is adherent. The attachment is dissected through until the ball has free movement in every direction. Then an incision is made through the lower lid into the conjunctival cul-de-sac along the margin of the orbit, leaving the lid attached only at its ends. Next a thin curved flap of skin is dissected below the incision in the lid, and large enough to cover the denuded conjunctival surface. This flap is turned on itself and tucked through the incision into the cul-de-sac, and attached by sutures to the lid, thus bringing the fresh surface in contact with denuded portions of the lid, and the skin surface against the ball. Hotz's mode of operating for extensive symblepharon is by Thiersch's method of skin grafting. The eye is first thoroughly cleansed and the part for receiving the graft is prepared by dissecting through its attachment, or by carefully denuding its surface of cicatricial tissue. The inner surface of the forearm is washed with soap and water, and then with a solution of bichloride of mercury. A sharp razor which has been rendered aseptic by being dipped in boiling water is then laid flat against the arm, and by a gentle sawing motion a thin layer of skin is shaved off. This is trimmed to the proper size and laid on the denuded surface. No harm is done if the graft is larger than the denuded part. The lid is gently closed over the graft and the eye is dressed aseptically. The new surface will be lighter in color than the surrounding mucous membrane, and will remain so for a long time, but the flap rapidly grows to the part, and soon takes on the nature of the conjunctiva.

Transplantation of the conjunctiva of the rabbit has been successfully accomplished in several cases when extensive adhesions have existed. The flap should be larger than the denuded surface and free from subcutaneous tissue, and the sutures should be inserted before its removal from the rabbit. It should be kept warm and moist. Flaps of mucous membrane may also be taken from the lip of the patient. All bleeding must be stopped before the flaps are applied.

BLEPHARITIS.—This disease is at times very obstinate, and the remedies commonly used may fail to produce any change for the better. It is well to remember that the cause may be constitutional, and other than scrofulous, and therefore it is necessary to study closely the general condition of the patient. Syphilis is not an infrequent cause of the inflammation, and especially in this form are the roots of the ciliæ diseased. The diseased ciliæ are readily recognized by their bulbs being black instead of white, which is due to the diseased condition of the lid margin. The inflammation at times causes swelling of the entire lid, and may extend to the ocular conjunctiva. The inflammation in some cases partakes of the nature of eczema or other skin disease, and is then very difficult to manage.

The general treatment of blepharitis is thoroughly outlined in the article of Dr. Williams. In obstinate cases we should always suspect syphilis, and they may be treated accordingly with mercury and iodide of potassium. It may be necessary to give the latter in large and increasing doses, especially when the condition has lasted a long time and the lids are very much thickened by infiltration. In those cases that partake of the nature of skin disease the internal use of arsenic may be followed by good results, and much benefit may be derived from the use of an ointment of aristol (gr. xv. to vaseline gr. lxxviii.). This should be applied to the margins of the lids, once or twice a day, after the usual cleansing of the parts. Some cases of blepharitis are due to refractive errors and are cured by the use of proper glasses.

THE LACHRYMAL APPARATUS.

INFLAMMATION OF THE LACHRYMAL GLAND.—This is rather rare, but occurs in both an acute and a chronic form. The acute is more frequent among children and is generally caused by trauma. The chronic form is at times bilateral and then is usually of syphilitic origin. The symptoms of inflammation of the lachrymal gland are swelling of the lid, partial ptosis, displacement of the ball downward and inward, and pain. Sometimes an abscess forms and breaks through the lid, leaving a fistula that is difficult to close. This condition may be congenital. The gland in some cases is simply hypertrophied. Abscesses are of course treated according to general principles.

MALIGNANT TUMORS OF THE LACHRYMAL GLAND.—These are sarcomata and carcinomata, and they cannot always be distinguished in the beginning from simple hypertrophy. The *treatment* for malignant growths is early and thorough excision, care being taken not to cut the levator palpebræ muscle.

THE TEAR PASSAGES.—It is now admitted that the most frequent cause of *obstruction of the tear passages* is swelling of the nasal mucous membrane, which closes the nasal end of the duct and causes a damming of the tears in the sac, epiphora, dacryocystitis, or abscess. A case is reported by Malgat where a piece of lettuce which was forced into the duct during the act of sneezing caused an abscess. Syphilis is a frequent primary cause of obstruction of the tear passages, usually beginning in the nose. Lachrymal abscess sometimes occurs in women during the early months of pregnancy, and, according to Mr. Powers, is caused by the congestion of the nasal mucous membrane following vomiting. Sometimes epiphora is caused by papillomatous growths obstructing the canaliculi, but this is rare.

Treatment.—When cases of epiphora are seen in the beginning it is generally easy to prevent serious consequences, but unfortunately, when the case is seen by the surgeon, the mischief often has already been done. For the slighter cases caused by catarrhal inflammation of the conjunctiva and adjoining mucous membranes it will be sufficient to wash out the sac with a weak solution of bichloride of mercury (1 in 10,000), boric acid and salt, or peroxide of hydrogen properly diluted with boiled water. At the same time the nasal mucous membrane should receive appropriate treatment by spraying, douching, insufflation of powders, or stronger applications, according to the condition of the parts. It is difficult to abort an abscess after it has once begun to form, and it should therefore be poulticed and opened early by a longitudinal incision at the most prominent part. The sac and infiltrated tissues may now be carefully cleansed by injecting an aseptic solution through the opening. As soon as the inflammation has sufficiently subsided treatment of the sac should be commenced through the canaliculus, either being used. Ophthalmic surgeons are becoming more conservative in dealing with the tear passages, and though there are still a considerable number who slit up the canaliculi for preparatory treatment, many are coming to the conclusion that it is far better to treat these affections with as little mutilation of the parts as possible. Therefore they dilate the canaliculus until sufficiently large to admit the small nozzle of a syringe, and by this means the sac is cleansed, for if the liquid fails to pass through the duct it will escape by the other canaliculus. Generally it will be found that a variable quantity passes through into the nose, and that is reason enough for not cutting strictures by specially devised knives, or using large-sized probes that make gutters of capillary tubes. It must be admitted that in cases of lachrymal abscess when the tissues of the face have become infiltrated, and the bones of the orbit and nose are involved, it may be necessary to slit a canaliculus in order that the parts may be more thoroughly cleansed. Dividing strictures only causes the formation of cicatricial tissue which will prove a future menace to the lumen of the duct. The employment of large probes seems unnecessary, for in reality the probe should only be of sufficient size to give an outlet to the fluids, and should be used only as long as may be needed for the parts to recover their normal condition, which is now more readily accomplished than formerly, by strictly aseptic measures. When the duct becomes occluded by bone at the nasal end, the treatment advocated by Caldwell is probably the best. He uses an electri-

cal trephine on the turbinated bone until the duct is reached, and then cuts out the sides of the duct until the probe, which has been entered from above, is exposed. This gives a free outlet for the fluids and the case is then easily treated. However, the progress of cases of lachrymal obstruction is frequently unsatisfactory, partly because they are not seen by the surgeon until considerable mischief has been done, and again because the treatment is necessarily protracted and many patients become discouraged. Therefore, when the patient lives at a distance, or is unable to continue treatment, or when for any other cause this cannot be followed systematically, it is better to slit the lower canaliculus and teach him to use a probe on himself. In such cases a No. 3 Bowman probe should be selected. When the conservative plan of treatment is adopted, the canaliculus should first be cocainized, and a small silver probe should then be introduced into the sac and followed by the small nozzle of a syringe through which cocaine may be injected into the sac and duct. It will generally be found that the probe now passes easily into the nose. The waste ways being open, the cleansing fluid (solutions of bichloride of mercury 1 in 8000 or 1 in 10,000, boric acid and salt, peroxide of hydrogen, or simple salt) may be syringed through. The peroxide of hydrogen has the advantage of hunting out all the pus, and especially when infiltration has occurred. These cleansings should be continued daily until all discharge ceases. At the same time the patient may supplement the treatment by using at home any of the above-named solutions in the cul-de-sac, or mildly astringent washes, among which may be mentioned alum in the distilled infusion of witch-hazel. Pyoktanin (1–1000) has been advised, but it is only in chronic cases that any good can be expected from its use, and even then it is uncertain.

In cases where no benefit results from treatment, the sac may be excised or destroyed by the actual cautery. For excision a cut should be made directly down upon the sac, which is then seized by forceps and dissected out. Syphilitic cases are treated by mercury and iodide of potassium, and usually respond promptly.

Diseases of the Conjunctiva.

Conjunctivitis.—For the milder forms of conjunctivitis which are caused by the irritating influences of cold, dust, or light, non-irritating washes are by far the most useful, and are followed by the best results. Bathing the conjunctiva with boiled water, or spraying and douching with the same, either cold or warm according to circumstances, will often afford much relief and be all the treatment that is necessary. For catarrhal inflammation and blepharitis, thorough cleansing with boiled water and castile soap several times a day, with the alternate use of the boric acid and salt solution, usually quells the inflammation. The stronger astringent solutions of nitrate of silver, zinc, alum, copper, and tannin are apt to increase the irritation in acute cases and are therefore contra-indicated, but for chronic cases they are very useful. The solutions of nitrate of silver are still the most highly prized, and are used in varying strengths, gr. $\frac{1}{6}$–gr. x. to f $\overline{3}$ i. Only in the very severe cases will the stronger solutions be necessary. At times acute

attacks of catarrhal conjunctivitis with profuse muco-purulent discharge may be cut short by the thorough application of nitrate of silver, gr. iv.–x. to f℥i., but the cases for such treatment should always be carefully chosen. Solutions of bichloride of mercury do not seem to be indicated in the treatment of acute conjunctivitis, as a solution of only 1 in 5000 has caused serious irritation in these cases.

OPHTHALMIA NEONATORUM.—This is probably caused oftener by the gonococcus than by any other germ, but there are undoubted cases in which its presence cannot be demonstrated. Credé's method of instilling one or two drops of a two-per-cent. solution of nitrate of silver into the eyes of infants immediately after birth, is still the recognized preventive treatment, and this precaution has caused a vast reduction in the number and severity of cases. Certain states have adopted laws requiring all midwives to report to a physician every case of eye inflammation occurring in new-born children under their care, and the penalty for failing to make such report is fine, or imprisonment, or both. Laws of this kind, if properly enforced, would go far toward stamping out the greatest cause of blindness, and should be universally adopted.

GONORRHŒAL OPHTHALMIA.—This inflammation is caused by the gonococcus getting into the conjunctiva, and its presence may always be proved by the microscope even when the source of infection is unknown. The symptoms are too well known to be repeated here, and the diagnosis is easy. If seen in the first stage, when the entire conjunctival area is reddened and the eye is weeping, the attack may be aborted, or the severity lessened, by prompt and energetic treatment. This consists in perfect cleanliness and the use of nitrate of silver, which is the most important remedy for this disease. Usually it is not necessary to use solutions stronger than two per cent., but when the discharge is very profuse and the cornea is threatened, the strength may be increased to twenty or thirty grains to the ounce, or even more. Unless accustomed to treating these cases it will be more prudent to employ the weaker solutions. The strictest attention must be paid to the cornea, and a critical examination should be made several times a day when possible. Softening, which is indicated by haziness, shows that the microbe has made its way through the epithelium. Atropine to allay the irritation is at once indicated, and the efforts to secure cleanliness must be redoubled. It has been advised (Hinde) to apply strong solutions (1 in 500) of bichloride of mercury to the infected spot, but the use of this remedy requires caution. French surgeons have advocated the use of the actual cautery, and report cases as saved by this treatment. Ice-cold cloths should be applied continuously to the lids until all active symptoms have subsided, for by the use of cold multiplication of the gonococci is restricted. The sound eye must always be sealed and every care taken to prevent it from becoming infected. Bandages and dressings to the inflamed eye are unnecessary unless perforation of the cornea is threatened, or has occurred. Finally, when possible, a nurse should be in constant attendance upon these cases, and too much care cannot be exercised by the surgeon and attendants that they themselves do not become infected. The pus will

at times spurt from between the swollen lids when opened, and the danger to those around is imminent. The hands of all in attendance should be carefully washed with soap and water, and then in a solution of bichloride of mercury (1 in 1000).

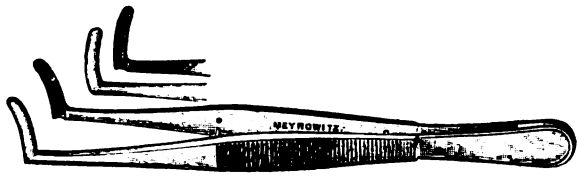
TRACHOMA; CHRONIC GRANULAR CONJUNCTIVITIS.—Muttermilch says that the microbe of trachoma has not been found because it does not exist. According to Fuchs, "there is but one kind of trachoma, which, however, appears under various forms." He thinks that the disease can be traced back to gonorrhœal infection which has caused acute blennorrhœa, and that, this becoming chronic, its secretion has produced in the healthy eye trachoma, which has continued to spread itself as such. The numerous descriptions which have been given of the disease have caused no little confusion, but it may be briefly said to have in the beginning distinct papillary elevations with hypertrophied conjunctiva and purulent secretion. These elevations coalesce and form large, irregularly shaped elevations, flat or rough, and finally absorption sets in, connective and cicatricial tissues form, and the lid shrinks, becoming dry and curving upon itself, when entropion follows. The eye irritated by the rasping of the lid becomes rough, pannus forms, growing from the upper corneal margin, and this formation of connective tissue and blood-vessels gradually forces itself down between the conjunctival covering and Bowman's membrane, until the entire cornea may be covered and blindness follows.

Follicular Conjunctivitis.—This is regarded by Fuchs as separate and distinct from trachoma, while others are equally positive that it is but a form of that disease. Follicular conjunctivitis occurs quite frequently among children, while trachoma is rare among them. The follicles of the former are smaller, more sharply formed, and are commonly arranged in parallel rows on the conjunctiva, especially of the lower lid. There is little or no pain, and no formation of pannus connected with the presence of these follicles, and they may exist for months without the patient suffering any inconvenience. At times follicular conjunctivitis follows the prolonged use of atropine, and it may possibly be due to the presence of some germ in stale solutions. The simple eye washes are sufficient treatment for the lighter cases, while for the severer cases more heroic measures are necessary, such as pressing out the contents of the follicles by the finger nails, or by specially devised forceps. In some cases recovery takes place without any treatment, and without the conjunctiva becoming impaired.

Treatment of Trachoma.—The acute stage of trachoma must be treated by soothing washes (boric acid and salt), ice-cold cloths should be applied to the lids, and upon any threat of corneal invasion atropine should be instilled. Weak solutions of nitrate of silver (gr. i.–iv. to f℥i.) may be carefully employed at this period, provided no serious reaction follows. As soon as the acute stage has passed and the eye is less irritable, stronger applications are indicated. One of the most efficient, in that the results are excellent and that the patient may if necessary apply it himself, is the solution of bichloride of mercury in varying proportions (1 in 300, 500, or 1000). Several drops may be placed on the inflamed conjunctiva once or twice a day, according to the effects produced. The pain after the first applications will be in-

tense, and will often continue for an hour or longer, but gradually the parts become more tolerant and the pain less severe, and the applications may then be made twice a day. The crystal of copper sulphate, strong solutions of tannin and glycerin (gr. x.–xxx. to f ʒ i. or stronger), and boroglyceride (fifty per cent) may all be used during this stage. The copper, though an effective and highly prized remedy, is severe, the pain from a single application not unusually lasting for several hours, and at times all day, and it should therefore only be used by

Fig. 1699.



Noyes's Trachoma Forceps.

skilful hands. The popular treatment for this stage is the surgical, which consists in expressing the contents of the follicles by means of the finger nails or specially devised forceps, or in incising the conjunctiva in lines parallel to the lid margin with a special instrument, and then, with a nail-brush or tooth-brush that has been dipped in a solution of bichloride of mercury (1 in 100, 200, or 300), brushing out their contents. This method is known as "grattage," and has been recommended by Darier and other French surgeons. The forceps designed by Noyes and by Knapp (Figs. 1699, 1699 *bis*) are among the best for the treatment by expression. Patients are placed under the influence of an anæsthetic, or perhaps strong solutions (ten per cent.) of cocaine may answer. Noyes uses two pairs of forceps, and with one grasps and everts the lid, while with the other the folds of the conjunctiva are caught, and by pulling against the first pair the contents of the follicles are pressed out. Knapp's is a roller-forceps, and by its use the conjunctiva is milked, as it were, both arms being at times

Fig. 1699 *bis*.

Knapp's Roller-Forceps for Trachoma.

within the cul-de-sac, though when the edges of the lid are reached one may be placed outside. Considerable reaction follows these operations; but beyond washing with a solution of boric acid, and applying iced cloths externally, no immediate treatment is necessary. Adhesions between the torn and mangled conjunctival folds may be prevented by breaking them up daily with a probe. As soon as the reactive symptoms have subsided the treatment may be supplemented by the use of astringent washes, careful applications of the crystal of copper, boroglyceride, and solutions of nitrate of silver. No exact rules can be laid down for this stage, but the case must be treated according to cir-

cumstances. Pannus is still treated by performing peritomy, but in those cases where there are thick pannus and rough, tough excrescences on the conjunctiva, no remedy can accomplish more than jequirity. This may be employed in a three-per-cent. infusion, or as a powder sprinkled upon the pannus and lids. Two or three applications of the infusion are sufficient to produce the desired inflammation, which begins usually within twelve hours, and at the end of twenty-four is well under way. When the pannus is old, tough, and thick, the inflammation should continue two or three days, and then be gradually checked by frequent cleansing with boric-acid solution. It is better to accomplish too little than to run the risk of destroying the cornea, for the process may be repeated as often as is necessary. The pannus has been seen to slough away in large pieces. Jequirity is contra-indicated in cases of ulcerated cornea, when there is much discharge, and in all acute cases.

PHLYCTENULAR OPHTHALMIA.—This form of inflammation of the conjunctiva and cornea, on account of the intimate connection between the parts, will be considered under the above heading. The appearance and symptoms are well known and need not be dwelt upon here. The phlyctenula is a collection of round cells situated beneath the epithelium in the conjunctiva, and between the epithelium and Bowman's membrane in the cornea. When the cells pass through this membrane and penetrate the cornea a hazy spot is always left. The primary cause of phlyctenular inflammation is undoubtedly constitutional, but some writers contend that nasal complications are always present and that treatment of the nose cures the eye. The nasal affections are hypertrophy of the turbinated bones, and polypi and other growths that are found upon the mucous membrane of the nose and naso-pharynx. The nasal hypertrophies frequently cause obstruction of the duct, and it is quite likely that poisonous germs from the sac find their way along the canaliculi and finally infect the conjunctiva and cornea. The predisposing constitutional diseases are syphilis and scrofula, and at times it may occur when the system is run down, as while teething, and conjunctival phlyctenulæ are at times seen even in apparently healthy children, though doubtless due to some latent but slight disorder of nutrition. Refractive errors, and astigmatism especially, are said to be causes. Undoubtedly constitutional weakness and dyscrasiæ have much to do with the disease, and it is not unlikely that the same cause produces that of both eye and nose, and that the treatment of one organ is incomplete without that of the other, both being improved by constitutional remedies. Therefore it must be concluded that phlyctenular ophthalmia occurs most frequently in strumous and syphilitic children, in whom all mucous membranes are prone to inflammation and hypertrophy; that malarial, unsanitary, and bad hygienic surroundings are usually the direct causes of attacks; and that not only the membranes of the eye and nose are involved, but frequently that of the alimentary tract also.

Treatment.—The patient's surroundings when bad should be improved, change of climate is beneficial, good and nourishing food is essential, and out-of-door life is not to be restricted. The condition of the general health should receive careful investigation, and indigestion

or mal-assimilation should be corrected. All throat and nose complications should receive appropriate treatment, and as soon as the irritation of the eyes has sufficiently subsided they should be examined, while under the influence of a mydriatic (preferably atropine), for refractive errors. When found, these should be corrected by the proper glasses. When the conjunctiva alone is affected, calomel dusted on the eye and the simple washes are all that is necessary, unless the ulcer should prove obstinate, when it may be touched daily with a five-grain solution of nitrate of silver. Corneal invasion will be treated of under the next heading.

Affections of the Cornea.

The three principal layers of the cornea, viz., the epithelium, Bowman's membrane and the cornea proper, and Descemet's membrane, correspond to the three coats against which they abut, viz., the conjunctiva, sclera, and uvea (iris and ciliary body), and in fact the microscope does not show any sharp line of demarcation between the cornea and sclera, the fibres of each passing imperceptibly into the other. The cornea is therefore from its intimate connection with these parts most likely to sympathize, or by contiguity and continuity to be infected or affected, by any abnormality existing in them.

Keratitis.—Inflammation of the cornea may be *suppurative* or *non-suppurative*. The first stage is *infiltration*, and in the non-suppurative form resorption takes place.

In *suppurative keratitis* there are three stages, viz., infiltration, suppuration, and cicatrization. Fuchs says: "We must first examine the corneal reflex. If the surface is dull, we are dealing with a recent affection, and in that case, if there is no loss of substance, with an infiltrate or with an abscess; but if a loss of substance is present, with a foul ulcer. If the surface is lustrous, the affection is an old one; if a loss of substance is present, it is a clean ulcer that we have before us; but if no loss of substance is visible, we are dealing with a cicatrix." An easy and positive way of diagnosing corneal inflammation or injury is by the use of the solution of fluorescine, which stains all breaks and softened spots in the epithelium a green color. In suppurative keratitis there is always a loss of tissue when the ulcer extends below Bowman's membrane. True corneal tissue is never reproduced when once destroyed, and healing takes place by cicatrization which begins from the sides and bottom of the ulcer. *Non-suppurative keratitis* may result in perfect recovery of vision, but if the cellular elements are not entirely resorbed, then haziness remains. This haziness may be in the corneal layers or on the membrane of Descemet, and accompanying iritis with synechiæ may be a strong factor in causing dimmed vision.

Treatment of Suppurative Keratitis.—Cleanliness is of prime importance, and when the ulceration has been caused by disease of the lids, this should be vigorously treated. The solutions of boric acid and salt, bichloride of mercury (1 – 1000), and chlorine water are sufficient for cleansing. Atropine is most important for allaying irritation and preventing iritis, though it is hardly possible to do this. For chronic

ulcers with little discharge, and for those of traumatic origin, the bandage may work wonders. When ulcers show a tendency to extend, with the formation of hypopyon, nothing avails but the use of the actual cautery, and this must be boldly applied to every point. Abscesses and ulcers accompanied by large deposits of pus in the cornea or anterior chamber should at once be treated by Saemisch's method of incision and evacuation. After this the wound and anterior chamber must be carefully washed out with the solution of boric acid. Ulcers that tend to extend gradually over the cornea, such as have been called serpiginous and dendritic, are often difficult to control and are very chronic. When the pupillary area is likely to be involved the actual cautery renders valuable assistance. Eserine is useful at times, but is generally found to do most good in old and chronic ulcers that perhaps have been caused by some lid affection. Rarely is eserine useful in acute ulceration, but in one rapidly progressing case which had been caused by the injudicious use of jequirity in an acute attack of granular lids, eserine at once changed the condition and saved the eye. Threatened perforation of the cornea must be guarded against by bandaging, and occasional paracentesis may be required until the corneal tissues have regained their strength. This of course renders infection of the anterior chamber more liable to occur if there is much discharge, but this procedure is preferable to having the cornea burst, leaving a ragged opening and prolapse of the iris. The opening in the cornea should be in the healthy portion and as far from the ulcer as possible, in order that there may be less danger of infection. The employment of eserine and atropine to prevent prolapse of the iris is not practically useful, for when the break occurs the iris goes in, and besides, in those cases in which eserine has been used there is greater danger of the formation of synechiæ. Should perforation have occurred before the patient is seen, nothing can be done toward reduction, and on no account should the iris be interfered with, for, acting as a plug in the wound, it prevents further infection of the anterior chamber, and keeps the aqueous humor from escaping and thus causing obliteration of the chamber. Absolute cleanliness is essential, and beyond this little treatment will be necessary. At times weak solutions of atropine will aid very much in allaying the irritation, but at other times they increase it, so that it is only by trial that their effect can be known. Gentle pressure should be kept up by a bandage to prevent further bulging of the iris in the wound, and in time the inflammation will subside, the projecting portion will become flattened, and nothing but the hazy spot and distorted pupil will remain. Finally, constitutional treatment is of paramount importance, and the digestive functions should receive careful supervision and regulation when necessary. The scrofulous cases are generally very tedious, and it will often tax the skill of the surgeon to meet the many complications that arise. Those cases which are due to malarial poison are benefited by large doses of quinine, repeated at short intervals for several days and then gradually diminished. For obstinate cases of malarial or other origin, arsenic in the form of Fowler's solution, and given in ascending doses, is of decided benefit. Keratitis is at times caused by delayed or irregular menstruation, and then usually disappears when that function is established.

Hazy corneæ are often much benefited by massage with the ointment of the yellow oxide of mercury (gr. ss.–i. to ʒi. vaseline).[1] The rubbing should be systematically performed in every direction with the lid and finger. The improvement is very gradual. Electrolysis has been employed by Alleman and others for leucoma, and they claim with gratifying results. While the cornea is still irritable atropine should be continued, and in not a few cases it will aid greatly in clearing away slight nebulæ. For the dense central leucomata, iridectomy when practicable will of course be necessary.

The *sequelæ of ulcerated cornea* are hazy spots (nebula and leucoma), synechiæ, staphyloma, cataract, panophthalmitis, and destruction of the globe. *Small staphylomata* are sometimes reduced by bandaging and supporting the weakened parts until they have thoroughly healed. Again the performance of iridectomy will at times cause a subsidence of the swelling. *Large staphylomata* may be treated by *posterior sclerotomy*, as advocated by de Wecker. This is performed by drawing the eye downward and inward with the fixation forceps, and with a Graefe knife making an incision through the conjunctiva and sclera, back of the ciliary body, and between the superior and external recti muscles. The opening may be a little greater than the breadth of the knife, care being taken not to make the incision in the sclera directly under that in the conjunctiva. Immediate improvement must not be expected, as a year or more may elapse before the good effects are seen, and in some cases the operation is of no benefit. Other operators *excise the staphyloma* in various ways and draw the edges of the wound together with a continuous or interrupted suture. *Enucleation* is necessary when the protrusion is very great, or *evisceration* may be preferred. This operation can be done with the eye under the influence of cocaine. For its performance a speculum, fixation forceps, scissors, knife, and scoop are necessary. The conjunctiva is loosened about the cornea and with the knife an incision is made through the sclera. The cornea is excised by the scissors or knife, the contents of the globe evacuated, and the inner surface of the sclera is scraped in order that the choroid may be entirely removed. The cavity is cleansed with any antiseptic solution, or, as Prince has suggested, may be wiped out with a solution of carbolic acid to prevent the pain which is usually severe. The edges of the conjunctiva are drawn together by the continuous suture. Considerable reaction follows the operation, and healing is slow. It is claimed that a better stump for an artificial eye is gained in this way, and that hence the operation is preferable to enucleation. Mules has introduced a glass ball into the scleral cavity and closes the sclera over it. This makes a good resting place for the artificial eye, and Mules, with others, speaks highly of the results.

CONICAL CORNEA.—This change in shape is due to a thinning at the centre of the cornea, the pathology of which is not understood. It occurs in both eyes, in males and females, at times affects several members of the same family, and in some instances has seemed to be hereditary. The process is slow and can rarely be controlled. Several

[1] This ointment is less irritating when the mercury is first rubbed up with a few drops of olive oil, and the ointment then made with vaseline or albolene.

modes of treatment have been tried, such as trephining the apex and removing a plug, and cauterizing with lunar caustic, but the results have not been satisfactory. The operation described by Knapp[1] has probably been followed by the best results and seems most rational. He employs with the galvanic cautery an electrode with an oval plate, 3 by 2 mm. This is applied cold a little below the centre of the cornea, and is removed as soon as it is brought to a red heat. He is careful not to allow the instrument to penetrate the anterior chamber, and thereby prevents the formation of synechiæ. A second operation may be necessary, but this is preferable to causing too much reaction by the first. It may be necessary to perform a subsequent iridectomy for optical purposes.

TUMORS OF THE CORNEA.—These may be dermoid cysts, which are congenital and are attached at any portion of the margin, or fibromata, which are very rare, while in one or two instances corneal polypi have been reported. The malignant tumors which at times attack the cornea do so by extension from the iris, choroid, or ciliary body.

PTERYGIUM.—Ophthalmic surgeons still differ as to the origin of this growth, or overgrowth, of the conjunctiva. Contrary to many opinions, Fuchs claims that pterygium has its starting-point in a pinguecula, which during the degenerative process extends upon the cornea and then draws the conjunctiva after it. True pterygia occur only at the inner and outer margins of the cornea, those found at other points having their origin in corneal ulcers to which the conjunctiva becomes attached. This variety rarely if ever shows any tendency to extend. Pterygium, while it may occur more frequently in elderly persons, is by no means uncommon among young men, but is much less common among women of any age. Several methods of removal have been described, but that advocated by Prince seems the most satisfactory and thorough. It consists in grasping the growth at or near its corneal attachment and gently tugging until it is entirely detached. With the eye under the influence of cocaine there is no pain, and the removal, as far as the cornea is concerned, is absolute. Bowman's membrane is usually separated from the cornea proper, and a white and glistening area, caused by the partial separation of the corneal layers, is temporarily seen, but soon disappears, the cornea healing without any opacity, which is not always the case when the dissection method is employed. After removal of the pterygium the edges of the conjunctiva are dissected back, and are then drawn together by sutures. It has been advised to make two vertical slits in the conjunctiva near the cornea, above and below, which prevent the conjunctiva being folded over the cornea when the sutures are tightened. When large pterygia are removed Hotz has advised skin grafting by Thiersch's method to fill the gap. After the operation has been performed the eye should be thoroughly cleansed, as has been directed, and a light dressing applied to keep it closed, for healing takes place faster than if it be left open. The sutures may be removed on the fourth or fifth day, and smoked glasses may be worn to protect the eye from light and dust. The part is likely to be sensitive for several weeks.

[1] Archives of Ophthalmology, vol. xxi., No. 4.

Affections of the Iris and Ciliary Body.

Iritis and Cyclitis.—Inflammation of the iris and ciliary body usually coexist, on account of their very intimate connection. *Iritis* begins with a hyperæmic condition of the iris which causes congestion of the blood-vessels and contraction of the pupil, the latter being aided by spasm of the sphincter from irritation. An exudation from the over-distended blood-vessels covers the surface of the iris, gives it a dull appearance, and changes its color. This exudation also produces a cloudiness of the aqueous humor, and when present in any quantity is precipitated in the anterior chamber, forming *hypopyon*. At times hemorrhages occur from the bursting of a vessel in the iris, the blood (*hypohæma*) occupying the anterior chamber. Exudation into the posterior chamber causes posterior synechiæ. These are best seen by reflected light as small projections from the pupillary margin into the pupillary space. Atropine at once proves their existence by producing irregular dilatation, unless the entire margin is adherent, when no dilatation occurs. The exudation may fill the pupillary space and interfere seriously with vision, while the seclusion caused by total posterior synechia does not at first necessarily impair the sight, though it usually causes increase of tension which may eventually produce blindness.

Cyclitis.—The exudation from the ciliary body covers that body itself, and passes into the posterior and anterior chambers and into the vitreous. In the anterior chamber it is seen as minute dots and specks covering the membrane of Descemet, and the situation of these spots in the same plane distinguishes them from corneal disease with which they have no connection. The exudation into the posterior chamber produces total posterior synechia, and exudation into the vitreous causes opacities which are readily seen with the ophthalmoscope. *Tension* is not increased in simple iritis, but may be so in the beginning of cyclitis, though in the end it is reduced. Pain, photophobia, ciliary injection, lachrymation and impaired vision are prominent symptoms of iridocyclitis.

Duration.—Acute attacks, when properly treated, last from two to six weeks, and the eye remains sensitive for several months afterward. Iritis cannot be aborted; when taken in time it can be cured, but when not treated and allowed to become chronic it never tends to recovery. There is often a tendency to relapse, especially in chronic cases, which is probably due to a continuance of the cause. Usually but one eye is attacked, though both may be simultaneously affected, or one may be involved before the other by one or two weeks. When seen before synechiæ have formed or have become firm, iritis may be cured, and vision will then be as good as before the attack, but when synechiæ remain vision will be impaired.

Sequelæ.—*Atrophy of the iris* rarely follows acute, but is common after chronic iritis. *Posterior synechiæ*, when few and slight, do not interfere much with vision, but when there is seclusion of the pupil increased tension may follow, and sight fails as in glaucoma. *Pupillary occlusion* shuts off light and prevents vision, while *exudation covering the ciliary body*, filling the posterior chamber, and causing a general matting together of the iris, ciliary body, and lens, by organiz-

ing and shrinking gradually detaches the retina from the choroid, and produces blindness. The eye loses its elasticity and becomes soft, the ball is smaller, the cornea is flattened and the anterior chamber obliterated, the iris is atrophied, and the positions of the recti muscles are apparent by their indentations in the sclerotic coat. The development of atrophy is slow and painless, except perhaps in cases where ossification occurs in the choroid.

Etiology of Iritis and Cyclitis.—The causes are primary and secondary, and Fuchs classifies them as follows:—

- A—Primary iritis
  - Iritis in consequence of general disease
    1. Iritis syphilitica.
    2. " scrofulosa.
    3. " tuberculosa.
    4. " rheumatica.
    5. " gonorrhœica.
    6. " in acute infectious diseases.
    7. " diabetica.
  - Iritis as a local affection
    8. " idiopathica.
    9. " traumatica.
    10. " sympathetica.
- B—Secondary iritis.

Syphilitic iritis is present in at least fifty per cent. of all cases. Besides constitutional symptoms there are usually nodules at the pupillary margin, but at times these are absent and, as far as the iris is concerned, there are no pathognomonic signs of syphilis. It usually follows the first eruption in the skin, but occasionally comes much later. When due to hereditary syphilis it is not so severe as in the acquired disease; the former is more commonly seen in children and young persons, whereas the latter occurs in adults. Syphilitic iritis is frequently associated with inflammation of the choroid, retina, and optic nerve.

Scrofulous iritis in appearance is somewhat like that due to syphilis. It is seen in children, young persons, and at times in the anæmic.

Tuberculous iritis is frequently seen in children. There are small nodules and at times larger growths. These eyes are usually lost, though occasionally they recover.

Rheumatic iritis occurs in persons of rheumatic diathesis. A similar form occurs in those who have gout.

Gonorrhœal Iritis.—This form is seen when the general system has become infected by the poison. It is liable to recurrence, especially in connection with fresh outbreaks of the urethral discharge and swelling of the joints.

The *iritis of acute and infectious diseases* occurs in relapsing fever, and at times in variola, typhus, etc.

Diabetic iritis is frequently associated with hypopyon, but its course is generally favorable.

Idiopathic Iritis.—The etiology of these cases cannot be traced, but it is probable that some of the above-mentioned causes are present though not recognized.

Traumatic iritis is produced by any traumatism, especially by blows, the presence of foreign bodies, injuries during operations, etc.

Sympathetic Irido-cyclitis; Sympathetic Ophthalmia.—The inflammation passes from the injured eye to its fellow. A sharp line must be drawn between *sympathetic ophthalmia* and *sympathetic irritation.* The latter, according to Schirmer, is a variable condition, but has two prominent characteristics, viz., no true inflammatory changes, and de-

pendence upon continued inflammation in the exciting eye; for as soon as this eye is removed all irritation disappears from the other. In order that there may be no mistake in recognizing sympathetic inflammation, three points must be considered: (1) the nature of the injury in the exciting eye, (2) the nature of the affection in the sympathizing eye, and (3) the length of time between the injury of the first and the implication of the second. Irido-cyclitis must exist in the exciting eye, and this has generally followed perforation of the coats allowing the entrance of microbes, which, not the wound as was at one time supposed, are the cause of the inflammation. The affection in the sympathizing eye is generally a uveitis, a papillo-retinitis, or a combination of both. The time that may elapse between an injury to one eye and sympathetic inflammation in the second is usually about three weeks, rarely shorter, though it may be a much greater period. Various causes have been suggested for the sympathetic inflammation, and among these are nerve irritation and the migration of bacteria. Irido-cyclitis is an essential condition in the exciting eye, and is caused by germ infection. Mechanical irritation of the ciliary nerves does not cause disease, and therefore cannot account for disease in the fellow-eye. Again the affection may continue or even return after the exciting eye has been removed, whereas had it been caused by nerve irritation it would have immediately subsided. The bacterial theory accounts more satisfactorily for the inflammation, but as to the path by which the germs pass from one eye to the other, or as to the real nature of the organism, observers are still in ignorance.

Treatment of Sympathetic Ophthalmia.—A blind eye that is capable of exciting inflammation should be at once excised. An eye containing a foreign body that cannot be extracted should be excised, unless it retains vision while the other eye is blind. An exciting eye that retains vision should not be removed when the other eye is affected, for in the end it may prove the better of the two. The removal of the exciting eye when the second has not been affected is a matter of grave importance, especially when good vision remains, and the case must be judged by a consideration of all the conditions. When inflammation has commenced, a blind exciting eye should be excised at once. When the patient refuses to have enucleation performed, a large portion of the optic nerve may be excised as a substitute, but the responsibility should be thrown upon the patient or friends. Sympathetic inflammation should be treated by atropine, pilocarpine, and mercury (by inunction if possible). The patient should remain in a darkened room and all use of the eyes should be prohibited. No operation should be performed on the sympathizing eye until all symptoms of inflammation have entirely subsided.

SECONDARY IRITIS AND IRIDO-CYCLITIS.—This usually follows keratitis, scleritis, retinitis, or choroiditis, and the iritis is generally severe, but chronic and sluggish.

TREATMENT OF IRITIS IN GENERAL.—Full dilatation of the pupil by atropine is of prime importance. This should be used freely and fearlessly, and the intense pain that is frequently caused by the tugging at the adhesions must not deter the surgeon from continuing its use until

sufficient time has elapsed to prove that the attachments cannot be broken. At times the iris is so engorged with blood that the mydriatic is powerless to affect it until blood has been taken from the temple by leeches, or by Heurteloup's instrument. The free use of mercury by inunction may greatly assist in causing the adhesions to give way, and therefore these two remedies—sometimes with the addition of iodide of potassium—should be pushed until the object has been accomplished.

Diaphoresis also may be followed by beneficial effects, and in all but traumatic cases of recent occurrence, hot applications not only help to draw the blood from the parts but greatly alleviate the pain. This being worse at night, a dose (gr. x.) of antipyrine, or phenacetin, given one or two hours before bed-time and repeated, often relieves pain and thereby induces sleep. At times morphine will be necessary. Paracentesis of the cornea may also be performed in extreme cases. For *traumatic iritis* ice-cold cloths are at first of most use in subduing inflammation, but afterward hot applications are preferable. *Syphilitic iritis* probably responds more promptly to treatment than the other forms, all of which should be treated according to their causes. Iodide of potassium is a safe and useful remedy in all. Synechiæ unless extensive may not cause much trouble, though some surgeons believe that they excite recurrent attacks, while others regard these attacks as due to a continuance of the cause.

Extensive attachments should be treated by iridectomy, though when the pupil is occluded this will avail little, because the capsule is then generally opaque. In these cases it will commonly be found necessary to remove the lens, and even then the pupillary space is apt to fill again with inflammatory material.

INJURIES OF THE IRIS.—The iris is frequently torn by blows that do not make an external wound, and lacerations may occur at the ciliary border, causing partial (irido-dialysis) or complete (irideremia) separation, and in the radiating fibres. The iris may also be retroverted so that it lies on the ciliary body. These injuries are usually followed by hemorrhage into the anterior chamber.

Treatment is simple. The eye should be protected from the light and atropine should be instilled to allay irritation. When an external wound has been made and the iris has prolapsed, it may, if soon after the injury, be replaced if it is not injured, but usually it will be found necessary to remove the incarcerated portion, after which the wound should be treated antiseptically.

TUMORS OF THE IRIS AND CILIARY BODY.—These may be cysts, tuberculous deposits, or sarcomata. *Cysts* usually follow penetrating wounds, and should be removed through an incision in the nearest corneal border, the iris and cyst being drawn out and excised. *Tuberculous deposits* must be treated expectantly, unless they show a tendency to extend, when the eye should be enucleated. *Sarcomata* of the iris are pigmented, while those of the ciliary body may escape notice for a time. Excision of the globe is the only proper treatment, and this should be performed early.

PUPILLARY REACTION.—When the pupils differ in size the cause is

usually pathological. *Mydriasis* may be caused by a spasmodic contraction of the radiating muscular fibres, or by paralysis of the sphincter (oculo-motor paralysis). The spasmodic contraction is caused by cerebral irritation. Paralysis of the oculo-motor nerve may affect the pupil alone, or may also involve accommodation, and may affect the extrinsic muscles which the nerve supplies. Its causes are syphilis, cerebral diseases, and such poisons as the mydriatic alkaloids and ptomaines. Paralysis of the sphincter and of accommodation may also be due to traumatism—concussion, acting locally—and to increased intra-ocular tension causing pressure upon the nerves. In complete blindness the pupil dilates from lack of reflex action due to loss of light perception. *Myosis* may be due to spasm of the sphincter fibres or to paralysis of the cervical sympathetic. The spasmodic variety is caused by beginning meningitis, by the myotic alkaloids, and by opium, chloral, and nicotine. Paralysis of the radiating muscular fibres is caused by paralysis of the cervical sympathetic, spinal injuries, and tabes dorsalis. This form of myosis may be distinguished by the fact that the pupil while failing to react to light will usually act synchronously with accommodation and convergence (Argyll-Robertson phenomenon).

Hippus is rapid dilatation and contraction of the pupil, probably due to nervous disorders.

Albinism.—Gould thinks that albinos are healthy in body and mind, and that there is no discoverable hereditary cause. He believes that the entire pathological influence is exerted upon the eye, and that the condition is caused by transparency of the iris which fails to keep out the light.

CATARACT.

The use of cocaine and the possibility of securing asepsis have simplified the removal of cataract and afforded brilliant results. The discovery that a cataract is forming in an eye does not now cause the mental depression and feeling of hopelessness, induced by anticipated blindness, that at one time characterized such cases, because the average man is now sufficiently well informed to know that the operation is at present so well understood, and so successfully performed, that restored vision is almost a certainty if the case is a proper one for treatment. Some surgeons believe that the progress of incipient cataract may be stayed, and that eyes thus affected may last a long time for useful vision. They advise thorough examination of these eyes, and recommend that all sources of irritation should be removed, that errors of refraction should be accurately corrected, that attention should be directed to the general health of the patient, and that, as far as possible, any irregularity or abnormality should be treated by appropriate remedies. The *time* for operating causes much discussion among ophthalmic surgeons, but it seems that an eye should be what Landolt calls "operable." By this it is meant that the lens should be of nearly uniform consistence, with a minimum amount of cortical substance—in other words "ripe"—"when there has resulted a pathological dehiscence between the crystalline fibres and their implantation upon the anterior, subcapsular epithelium." But vision may fail and yet

this condition of maturity not arrive, wherefore artificial ripening is practised by not a few operators. This is done by stroking the lens with any smooth instrument of proper size, either through the cornea, or directly from the anterior chamber after paracentesis has been performed, care being taken not to injure the iris. Others introduce the point of a needle just within the capsule and by this means hasten opacification. Again there are those who perform a preliminary iridectomy in addition to massage of the lens. The amount of vision in the other eye should have some influence in determining the time for extraction. When vision is still sufficient for the performance of the patient's ordinary duties, there is nothing to be gained by removing the cataract from the worse eye, but as soon as the second eye fails to such an extent that duties are interfered with, or there is difficulty in going about, the first lens should be removed if the eye is "operable." The general condition of the patient requires attention, and, before operating, the heart, blood-vessels, liver, and kidneys should be examined. Some operators prefer to keep the patient, if away from home, under observation for several days, and always administer a purgative or laxative a day or two before operating; while others prefer to operate at once, and unless there is constipation do not consider preliminary treatment necessary. Strict antiseptic precautions must be followed in preparing the instruments. When possible the patient should take a bath and put on clean clothes; the face must be thoroughly cleansed with a solution of bichloride of mercury (1 in 3000), the eyelids being carefully washed with soap and water. The eye is thoroughly bathed with the solution of salt and boric acid. Particular attention should be paid to the eyebrows and ciliæ, and to the beards of men. A clean towel should be folded around the head so that the hair may be entirely covered. The operator and assistant should carefully cleanse their hands, first with soap and water and then in a strong solution of bichloride of mercury or other antiseptic. Two or three drops of a four-per-cent. solution of cocaine are instilled at about fifteen, ten, and five minutes before commencing the operation. Some operators prefer to have the patient in a reclining chair, while others use an operating table, and many the bed upon which the patient is to lie afterward. It would seem safer to use the bed when possible, though some surgeons do not hesitate to operate even in their offices, and to send the patient home afterward by conveyance, or on foot if the distance is short. The speculum is used by most surgeons for separating the lids, but a few employ the elevator, and a lesser number hold the lids with the fingers. The incision is made wholly within the cornea, the puncture and counter-puncture being in the corneo-scleral junction. The incision is usually upward, but a few make it downward. The surgeon must exercise his judgment about the size of the incision, which should be governed by the probable size of the lens; this should have an easy exit, thereby preventing the retention of cortical matter. The quicker the incision is made the cleaner will be the edges of the wound, and the less liability will there be of the iris falling upon the edge of the knife. The capsule is lacerated by some operators as the knife passes through the chamber.

Probably the majority of surgeons now dispense with an iridectomy, and the advantages to be gained are, (1) saving of time, (2) less mutilation and less exposure to inflammation of cut surfaces, (3) mainte-

nance of a round pupil, and therefore better vision. The disadvantages are, (1) the smaller exit for the lens, (2) the liability of cortical matter being retained in a place where it may cause inflammation, and (3) the danger of subsequent prolapsus of the iris into the corneal wound. Both methods are to be recommended, but the surgeon must suit the operation to the case. For the typical, senile, ripe cataract, the simple operation is better; but when there is much cortical matter, when the iris will not return to its normal position, or when there is fluid vitreous, iridectomy should be practised. Unquestionably a preliminary iridectomy, performed several weeks before the extraction, simplifies the operation wonderfully, but there is, of course, danger by opening the eye twice, though the simple performance of iridectomy is rarely followed by any serious results, while the easy and rapid recovery of the patient upon whom the preliminary operation has been performed has much to recommend it. The claim that better vision follows the avoidance of iridectomy cannot always be substantiated. For lacerating the capsule several methods are advised, and each has staunch advocates. Some make a cross in the centre of the membrane, others a T-shaped opening, others a peripheral cut along the upper margin, and quite a number believe in tearing out a piece by means of special forceps. Any of these plans will answer the purpose of liberating the lens, but it seems that the peripheral laceration advocated by Knapp is most rational, because the cortical matter if retained in the capsule will then be where it can do no harm. Expulsion of the lens in the capsule is the ideal operation, but the danger of losing vitreous will prevent its adoption. Before expelling the lens it is advisable to remove the blepharostat. The lens may then be easily and safely expelled by pressing with the finger or spoon handle through the lower lid at the lower border of the cornea, and with the thumb or finger through the upper lid just above the cornea, the patient at the same time turning the eye downward. By this means vitreous is less apt to be lost. Any cortical matter is now carefully forced out by the same movements, or, which some operators prefer, the anterior chamber may be irrigated by special syringes. This practice has not been generally adopted, but is highly praised by those who advocate it. The eye and cul-de-sac are are now carefully washed with the solution of boric acid. Atropine is instilled by some surgeons, while others, who have equally good results, do not use it except in special cases. Eserine is sometimes used after the simple operation, but as it is likely to cause iritis it is better not to employ it, especially as the pupil naturally contracts after the extraction.

In the matter of dressings there is considerable diversity of opinion. Custom and satisfaction with results induce many to retain the bandage and pad, though the bandages are much lighter than formerly. Others prefer closing the lids with a piece of soft and flexible plaster, such as gold-beater's skin, or isinglass or glycerol plaster, while a few advocate no dressing at all. It is true that the best splints are the lids, and that heavy dressings tightly applied may cause the edges of the incision to gape, and thus protract recovery and increase for a time astigmatism, but a light pad of cotton applied over a square of aseptic gauze, and held in place by strips of silk isinglass plaster stuck to the forehead and cheek, or by a light gauze bandage, seems desirable as a

means of affording protection from blows, or from pressure accidentally applied. Many operators close both eyes after the operation, while a considerable number close only the one. The operated eye is usually kept closed for a week, and those who close both eyes generally keep the well eye closed for two or three days. When there are no signs of trouble the dressings are often left for three or four days without disturbance, but the comfort of the patient is increased by putting fresh dressings on every day, which can be done without detriment to the eye. It is safer to keep the patient quiet on his back, in bed, for a time after the operation, and if possible to keep him in bed for a day or two; but many surgeons do not confine their patients, nor do they insist upon their remaining quiet, and some even allow them to go to their homes after the operation has been finished, and require only that bright light should be excluded from the room. Atropine should be instilled on the third or fourth day if it has not been used before, in order to prevent adhesions of the iris to the capsule. Any pain or swelling of the lids should cause an examination of the eye to be made, and if suppuration has commenced in the incision nothing but the actual cautery will avail, and this should be thoroughly applied to every portion involved. Afterward atropine and aseptic solutions should be regularly used. Iritis should be treated as heretofore directed. When a secondary operation is necessary for opaque capsule, it should not be performed until all inflammation following the extraction has subsided. The same care should be exercised in cleanliness, and in tearing the capsule the vitreous should be disturbed as little as possible.

GLAUCOMA.

Ophthalmologists are still discussing the causes of glaucoma, and many new opinions are constantly being expressed, proving that our knowledge on the subject is still unsettled. It is pretty well decided that changes in the circulation of the eye produce the external appearance and the increase of intra-ocular tension. Richey maintains that gout is the true etiological factor of the chronic glaucoma, and "that acute glaucoma is merely a paroxysmal expression of the same affection; that local irritation, or trauma, excites an attack of glaucoma only in the presence of dyscrasia; that operation saves the eye during the paroxysm; that operation serves little purpose in chronic glaucoma, even when it does not, by irritation, hasten the disease process or precipitate a paroxysm; that chronic glaucoma is a neurosis, a progressive atrophy, with the feature of inflammation with deficient power, varied by periods of apparent rest; that correcting and controlling individual habits, especially in the character and amount of food taken, will do more to preserve vision than operation; and that there may be a possibility of aborting chronic glaucoma, if the tendency to it be recognized at an early date." Taking into consideration, therefore, that some constitutional defect or weakness has been the cause of the circulatory changes in the eye which have in turn brought on the glaucomatous attack, it is very necessary that the existence of any dyscrasia should be known, and that it should be treated by the most appropriate methods. When glaucoma supervenes, the operative treat-

ment is the only one from which any assistance may be expected, but in this, too, are many disappointments. C. S. Bull, after a large experience, concludes that operation upon a chronic glaucoma is a grave responsibility, and that the patient should be made fully aware of the doubt of benefit, and of the possible chance of utter failure and loss of vision. The stationary condition is better treated with eserine, and frequent examinations should be made; when the disease exists in both eyes and when vision is good, the more advanced should be operated upon first; iridectomy is not always followed by good results, but lessened vision or total loss may follow. All things being equal, the earlier the operation is performed the more likely is it to be successful; disease is generally present in both eyes sooner or later; the age and health of the patient determine the advisability of operation, fair vision in such cases precluding interference; the condition of the field of vision, the acuity of vision, and the depth of the anterior chamber, do not indicate the chances for success, the appearance and mobility of the iris being more important. When this reacts promptly to eserine, the operation is more apt to be successful (Nettleship), and in these cases the visual acuity and condition of the field are better; the depth of the excavation and color of the optic disk bear no fixed relation to the condition of the field or of vision, nor to prognosis; the condition of tension does not indicate the time for operating unless it steadily increases, nor does it necessarily affect the visual acuity or the field.

Gruening summarizes as follows in regard to iridectomy for glaucoma: 1. In acute inflammatory glaucoma iridectomy yields brilliant results. 2. In chronic inflammatory glaucoma without degenerative changes in the iris, iridectomy gives satisfactory results. 3. In chronic inflammatory glaucoma with degenerative changes in the iris, neither iridectomy nor anterior sclerotomy gives to the patient the desired relief. Posterior sclerotomy may do it at times. 4. In simple glaucoma iridectomy generally maintains the previous condition, and is therefore indicated. 5. In intermittent glaucoma the operation of iridectomy is often followed by reduction of sight.

HEMORRHAGIC GLAUCOMA.—This disease is comparatively rare, and fortunately so, because all cases have been invariably lost, the treatment ending in enucleation of the eye on account of the terrible pain. In most cases there is general arterial sclerosis, with profound hyaline or fibrous degeneration of the retinal vessels, the vessels of the choroid and iris being affected less regularly. Retinal vacuoles are found filled with fibrinous exudates, or empty, and they naturally accompany the hyaline degeneration of the vascular system of the retina. Hemorrhages may be present, or the blood may have disappeared by absorption (old cases). The choroid may show inflammatory infiltration, or may be healthy (Pagenstecher). The iris is affected as the choroid, except that the vessels are more apt to degenerate. Adhesive obliteration of the iris angle and of Fontana's spaces is not constantly found as in acute or subacute irritative glaucoma. When it exists, it is caused by increasing irritation of all parts of the globe and is not a cause of them. Hemorrhagic glaucoma seems to be a disease rather of retinal origin than of the uveal tract, as is irritative glaucoma (Poncet). The hardness of the eye is the only point in common. In the irritative form the

outlets of nutritive fluids are affected, but in the hemorrhagic form the retinal vessels. It is a general disease in which the eye participates; not a true glaucoma, but a local affection, the expression of a particular general condition. Excavations of the nerve and narrowing of the field on the nasal side are not common.[1]

Treatment.—The only hope of successfully combating the disease is to treat it vigorously during the "hemorrhagic period," and as Risley says, "our care must first be devoted to the general condition of the patient, and second, 'to remove the congestion of the eyeball.'" As the condition is that of general arterio-sclerosis, the patient must be carefully watched as to diet, occupation, and rest. Potassium iodide and bromide are frequently used, as are also iodide of iron and bichloride of mercury. When there is albumin in the urine Risley advises Basham's mixture with corrosive sublimate added, and avoids the iodine salts, and when there is turgidity of the choroidal circulation and headache he has employed ergot with good results. Malarial poisoning should be treated by quinine and arsenic.[2] Weak solutions of eserine may be of use and plain smoked glasses give comfort. Stilling and de Schweinitz have recommended chloral for its action in reducing tension. When "the period of confirmed glaucoma" has set in, enucleation is the only known means of relief.

Ophthalmoscopic Diseases.

Affections of the Vitreous.—Intra-ocular diseases and disturbances can only be diagnosed with certainty by aid of the ophthalmoscope, and, passing the lens, the vitreous comes next for inspection. When clear and transparent, acute diseases of the choroid may generally be excluded, and at times retinal diseases, but retinitis may exist without vitreous opacity. The vitreous is rarely primarily affected, but becomes so from lesions of the surrounding parts. *Vitreous opacities* are of various kinds. The large, irregularly shaped bodies that float about with the movements of the eye, or at times remain comparatively quiet, are the results of retinal hemorrhage. The dust-like opacities seen when the eye is suddenly moved, indicate choroiditis (syphilitic), while general opacity with string-like bands indicates an inflammation that has involved the ciliary body, choroid, and retina. In cases of myopia of high grade, vitreous opacities from choroidal involvement are frequent. Bodies that project into the vitreous may be detached portions of the retina, tumors, or collections of pus. Foreign bodies may, at times be detected by the ophthalmoscope, but in old cases are usually encapsulated. *Synchisis scintillans* is a condition of the vitreous in which it appears to be full of falling stars, and this is due to the presence of cholesterin crystals.

Treatment.—The blood from retinal hemorrhages usually disappears without any special treatment, though small doses of mercury will no doubt hasten the absorption. Opacities caused by syphilis are usually absorbed under the influence of mercury and iodide of potassium.

[1] Valude and Dubief (translated by A. A. Hubbell for Ophthal. Record, from Annales d'Oculistique, Août, 1892).

[2] University Medical Magazine, November, 1893.

Spalding and others treat vitreous opacities by hypodermic injections of pilocarpine, using gr. $\frac{1}{12}$ once a day for two weeks, unless the heart is weakened. The dose may be increased to gr. $\frac{1}{6}$, but usually gr. $\frac{1}{10}$ is sufficient. It is not necessary to produce the physiological effects. De Schweinitz advises the fluid extract of jaborandi in doses of ten drops three times a day. He also uses potassium iodide, and thinks eserine particularly valuable, especially in cases of hemorrhagic origin that are prone to become glaucomatous. For membranous opacities in the vitreous that can be seen and located by the ophthalmoscope, C. S. Bull advises division of the obstructions. The eye is cocainized, and a double-edged needle or Graefe knife is plunged into the vitreous, a little in front of the equator and about the lower edge of the internal or external rectus muscle, and the bands are divided. But little reaction follows, and the eye is kept closed for only two or three days. Bull reports marked improvement of vision in some cases.

CHOROIDITIS.—There are four distinct layers in the choroid proper. Choroiditis may exist some time before it is recognized, because not until the pigment layer of the retina has become involved can the changes be seen, and therefore the retina is inflamed when there is choroiditis and the condition is really choroido-retinitis. Inflammation of the choroid generally exists in spots (disseminated), or it may extend over the entire coat (serous and purulent). Berry distinguishes the types of choroiditis as follows: (1) disseminated choroiditis, atrophic and exudative; (2) senile central choroiditis; (3) syphilitic choroiditis; (4) sclero-choroiditis, anterior and posterior, and (5) purulent choroiditis, traumatic, embolic, and metastatic.

The *disseminated* form is the most common, and first appears as yellow or reddish spots, more or less round in shape. These subsequently become whiter and are surrounded by a border of pigment. The white patch is the sclera, which is exposed by the degeneration of the superimposed retina and choroid. The patches are seen first in the equator, and may spread and ultimately involve the macula, causing at first metamorphopsia and micropsia, and finally scotoma. Disseminated choroiditis is usually caused by syphilis, and is uncommon in children.

Senile central choroiditis is seen in old persons as an irregularly shaped patch of lighter color than the surrounding part, and occupying the macular region. It causes metamorphopsia and scotoma, thereby diminishing vision, but rarely causes blindness. No treatment does good.

Syphilitic choroiditis is a common occurrence among the late secondary and early tertiary lesions of syphilis, and is most frequent among elderly persons. There are vitreous opacities and hyperæmia of the disk, and vision may or may not be reduced. Perfect recovery may take place, or there may be permanent impairment of vision due to opacities and scotomata. Mercury, preferably by inunction, is the best remedy, and Darier's subconjunctival injections of the solution of bichloride of mercury (1 in 1000) may be tried, or the hypodermic injection of cyanide of mercury as advocated by Chibret.

Sclero-choroiditis occurs anteriorly and posteriorly when there is weakening of the sclera. The treatment is unsatisfactory.

Purulent choroiditis may be confined to the choroid, or may involve

all the tissues of the eye (*panophthalmitis*). It is usually caused by infection following traumatism, or by metastasis, especially occurring in children who have had meningitis. (This form leads to shrinking of the globe and never to panophthalmitis.) Sympathetic inflammation is not apt to follow the injuries which lead to this form of choroiditis, which may also be caused by infection from pyæmia, puerperal fever, erysipelas, suppurative endocarditis, and injuries about the face. Panophthalmitis is treated like any form of abscess, but it is safer not to enucleate or eviscerate the globe until all inflammation has subsided.

Tuberculous choroiditis exists rarely, and only in connection with general tuberculosis. It may occur in two forms in the same eye—as miliary tubercle and as larger masses.

Hemorrhage in the choroid is less frequent than hemorrhage in the retina, from which it may be distinguished by the different shape of the effused patch, which is more or less round in area, and lies under the retinal vessels.

Ossification occasionally occurs in old and shrunken eyes, and by pressure may excite inflammation and render enucleation necessary.

Detachment of the choroid is very rare, and is caused by traumatism, serous effusion, and tumors.

RETINITIS.—The circulation in the retina does not give any positive knowledge of the condition of the circulation in the brain or heart, and it is not always easy to diagnose anæmia or hyperæmia. The relative size of the arteries and veins may give some idea of their true condition, for in hyperæmia and inflammation the calibre, tortuosity, and length of the veins are generally increased while the arteries may not be changed. *Anæmia* of the retina is caused by hemorrhage, spasm of the vessels, the stage of collapse in cholera, and toxic doses of quinine, and most commonly follows atrophic changes in the optic nerve. Hemorrhages from the retinal vessels are common, and upon their situation depends their shape, those of the nerve layer being flame-shaped or linear, while those which are deeper are round and more solid. The subjective symptoms are interference with vision (usually sudden), scotomata, and metamorphopsia. Recent hemorrhages in the retina give objects a red appearance. The effused blood may be entirely absorbed and leave no bad results, or scotomata due to degenerative spots may remain. In old persons these hemorrhages, when numerous, may cause the so-called hemorrhagic glaucoma, and such cases should receive careful supervision for many months. Retinal hemorrhages may follow traumatism, or altered conditions of the blood and blood-vessels, and these changes are produced by pyæmia, septicæmia, ulcerative endocarditis, diseases of the liver, spleen, or kidneys, atheroma of blood-vessels, anæmia, hæmophilia, purpura, scurvy, diabetes, gout, malaria, disturbances of the circulation due to heart diseases, suffocation, compression of the carotid artery, menstrual disorders, and sudden reduction of tension following operations for cataract and glaucoma. Retinitis is usually associated with choroiditis and cyclitis, but at times exists as a primary inflammation in diseases in which there is an altered condition of the blood and vessels, such as septicæmia, syphilis, albuminuria, diabetes, anæmia, and oxaluria. With

retinitis, besides hemorrhages and the changes in the blood-vessels, there are often loss of transparency, changes in the papilla, atrophy, increased or diminished vision, change of field, pain, and photophobia. The prognosis is generally unfavorable on account of the connection with grave constitutional disease, and in most instances both eyes are affected.

EMBOLISM OF THE CENTRAL RETINAL ARTERY.—This occurs in elderly persons who have heart disease and atheromatous vessels. The onset is sudden, painless, and frequently occurs at night, or while making some exertion, such as stooping. Vision is quickly lost, and only in rare cases is regained by the plug being carried further on into one of the arterial branches. The ophthalmoscope shows the retinal vessels empty, or nearly so, with frequently interrupted or beaded currents. A foggy halo surrounds the disk and macular region, while in the centre of the latter is seen the characteristic "cherry red spot" due to the choroid showing through the layer of rods and cones. Massage and paracentesis of the anterior chamber may be tried with the hope of moving the plug, but treatment is of little use and atrophy soon follows.

DETACHMENT OF THE RETINA.—This is a serious and tolerably frequent occurrence in affections of the eye. It is usually situated in the lower portion of the fundus, is more common in men than women, and is seen oftenest in myopic eyes. The separation takes place between the nerve and pigment layers, the latter adhering to the choroid, and between them is a yellow serous fluid. The researches of Leber and Nordensen have pretty well proved that when not traumatic it is caused by a fibrillar shrinking of the anterior portion of the vitreous, causing first a rent in the retina, through which fluid enters and produces detachment. The edges of the rent are always turned toward the vitreous, and can at times be seen by aid of the ophthalmoscope. The subjective symptoms are impairment or entire loss of vision, metamorphopsia, and night-blindness; and these may be preceded by rays, flashes, and muscæ volitantes. The field of vision is also imperfect. The objective symptoms are at times difficult to make out, on account of the hazy vitreous, but are altered color and depth of the fundus, this being gray or bluish, and the vessels which cross over it being darker than normal. It is not focussed by the same glass as the other portions of the fundus, and the parallactic movements of the vessels over the fundus prove a difference in depth. The detached portion is at times pushed so far forward that it can be seen through the pupil without a glass.

Treatment is unsatisfactory. Probably as much benefit has been derived from placing the patient flat upon his back in bed and injecting pilocarpine hypodermically, as from any other method. Iodide of potassium may also be employed. Schoeler's method of injecting tincture of iodine (3 drops) near the point of rupture, thereby producing irritation that might cause re-adhesion, has not been satisfactory.

DISEASES OF THE OPTIC NERVE.—The normal optic papilla is nearly round or oval in form, with distinct edges, showing at times the white and glistening border of the sclera, and usually some choroidal pig-

ment that is more abundant at the temporal edge. It is lighter than the surrounding fundus, and with different shades of color on its own surface.

Optic neuritis is divided into *papillitis*, in which the papilla alone is affected, and *papillo-retinitis*, or *neuro-retinitis* in which the retina also is involved.

Papillitis is generally caused by cerebral disease, though this may also cause neuro-retinitis. The papilla is swollen and hyperæmic, it has a striated and rough appearance, and its edges are frequently obscured. The veins are distended and tortuous, while the arteries are not changed in size, or are smaller, and often disappear under the swollen tissues. The transparency is much less than normal, and the prominence, which is at times considerable, may be approximately measured by allowing 1 mm. for every 3 D. The amount of swelling is not always in relation to the loss of vision, for at times, when swelling is greatest, vision may for the time be unaffected, but sooner or later it commences to fail and may be entirely lost.

Optic Neuritis.—Sudden loss of vision has other causes than the swelling, whereas gradual diminution may be caused by compression. The field of vision is often concentrically narrowed or irregular, and at times more affected on the temporal than on the nasal side, while the color sense is lost to a considerable extent. Cerebral papillitis is usually bilateral, but has occurred on one side in cases reported by Hughlings Jackson in brain tumors involving the opposite hemisphere. Extreme swelling of the nerve has been known as "choked disk," and was supposed to be different from descending neuritis, but the distinction is untenable. Optic neuritis is caused most frequently by brain tumors, next by meningitis, hemorrhage (rare), hydrocephalus (uncommon), and at times by purulent inflammation of the middle ear, softening of the brain, and rarely by abscess. Valude reports a case of burn in the third degree upon which iodoform was used. This was followed by blindness, optic neuritis, atrophy, diarrhœa, headache, and vomiting. Afterward some vision was recovered, but no color perception. As to the true relation between papillitis and brain disease there has been some controversy, but Leber says, that intra-cranial tumors, as also tuberculosis, give rise to congestion of the vessels, secretory inflammation, hydrops ventriculorum, and increased pressure. The products of tissue-change of these neoplasms become mingled with inflammatory stimulus, and, passing with the cerebro-spinal fluid into the intravaginal space of the optic nerve as far as the eye, give rise there to neuritis and papillitis. The entire nerve may be inflamed, but owing to the collection of irritative fluid at the end, the most intense reaction occurs there.

Retro-bulbar neuritis has perhaps similar pathological conditions, but the papilla is little if at all affected. There is central scotoma, but it is not so regular as that of toxic amblyopia, nor is it confined to the same area, but may extend to the inner side of the point of fixation. Again it occurs generally in but one eye, though both may be affected, and it is equally common in men and women. It may be confounded with toxic amblyopia, but the scotoma and its monocular character are differential points. The prognosis is less favorable, and but less than half of the acute cases recover. The *treatment* must depend upon the cause. Tumors of the brain, if located, may be removed, as this branch of

surgery has been wonderfully developed. Removal of the fluid from the optic sheath (de Wecker) may do good, and all cases should be treated with iodide of potassium.

Atrophy of the optic nerve is primary, secondary, or consecutive. It is *primary* when it originates in the nerve itself; *secondary* when it follows changes in the retina, choroid, or central nervous system, and *consecutive* when it follows neuritis. In appearance the nerve is white and excavated (when primary), and the vessels are much smaller than normal. Examinations of light and color sense, and as to restricted condition of field, are important in deciding whether or not the process is progressive. Berry says that restriction of the field of vision, when more or less concentric, and especially when the sense of color is relatively more defective than the sense of form, is always suggestive of progression. Central vision is usually lost as restriction increases, and Berry again says, "in all cases where there is merely a central scotoma, without any narrowing of the field, the prognosis is good." It is often difficult to diagnose the cause of atrophy, and besides the ophthalmoscopic changes other symptoms of a general character must be taken into consideration, such as the reflexes, movements of the pupils, etc. Unilateral atrophies are usually caused by retinal or orbital changes, though the cause may be found within the cranium. Changes at the base of the brain cause pallor of the disk, but not constriction of the vessels unless there has been a papillitis. Nettleship shows that about seventy-five per cent. of cases of bilateral atrophy are due to the causes which produce degenerative changes in the sensory tracts of the spinal cord and brain. In tabes dorsalis atrophy occurs in about fifteen per cent. Primary optic atrophy is more common in men than women, and accounts for one-fourth of all cases of blindness.

Amblyopia, or *dimness of vision*, may be congenital, and therefore due to defects in the eye or at the visual centres, reflex, or traumatic. Certain drugs and toxic agents cause amblyopias in some of which there are special features. Under this head may be mentioned uræmic, glycosuric, and malarial amblyopia, that from loss of blood, that from drugs, and hysterical and pretended amblyopia. The prognosis in all may be favorable if the changes have not gone too far and if the causes have not existed too long. In *chronic retro-bulbar neuritis*, or *tobacco amblyopia*, there is but little to be learned by ophthalmoscopic examination, but more important is the central scotoma, especially for red and green. It is oval in shape, and extends between the fixation point and the blind spot. It is usually caused by the combined abuse of tobacco and alcohol, although it has been seen when tobacco alone was used. The lesion is in the papillo-macular fibres. The *prognosis* is good when the cause is abated, and the *treatment* consists in giving strychnine until its physiological effects appear.

Quinine Amblyopia.—According to de Schweinitz, prolongation of quinine blindness causes true atrophy, and thrombosis of the central vessels may be expected in severe cases of the toxic action of the drug. He concludes, "it seems, then, very likely that the original effect of quinine is upon the vaso-motor centres, producing constriction of the vessels; that finally changes in the vessels themselves are set up, owing, perhaps, to an endo-vasculitis; that thrombosis may occur, and that the result of all these is an extensive atrophy of the visual tract."

Later investigations (not yet published) by de Schweinitz prove that similar effects are produced by the other alkaloids of cinchona bark. Other cranial nerves are not injured. The *treatment* consists in discontinuing the drug, and in the exhibition of nitrite of amyl, strychnine, and digitalis. The other forms of amblyopia should be treated on general principles, it being of course first necessary to learn their cause.

Tumors of the Optic Nerve are exceedingly rare, and are divided by Leber into the *essential* and the *non-essential*. The former spring from the nerve-tissue itself, the latter from the sheath, and involve the nerve by extension. The growth of the essential tumors is very slow, lasting at times for years, and generally causing blindness and perhaps proptosis. The growths are usually myxomata or fibromata, and a case of neuroma has been reported. Operation has not as a rule been followed by good results.

TUMORS OF THE ORBIT.

These may be benign or malignant, and they may begin in the orbit or may extend from the neighboring cavities. Orbital tumors are rare, and especially those of the optic nerve. Usually orbital tumors do not spread to the eyeball, and therefore when both ball and orbit are involved, the former has generally been the starting-point. Upon the position of the tumor depends its effect upon the ball. Tumors occupying the space between the orbital muscles do not at first interfere with the movements or position of the eye, but may finally cause outward displacement, while those in other parts of the cavity press the eye upward, downward, inward, or outward, according to their position. Orbital tumors are bony (exostoses), vascular, cystic, lymphadenomatous, sarcomatous, and rarely carcinomatous. These tumors should always be removed as soon as discovered, when sometimes the eye may be saved, but usually vision is lost, and in cases of malignant growths death generally occurs. The entire orbital contents should be removed when the tumors are malignant, but when the surrounding cavities and bones of the face are invaded, the operation, while it may give temporarly relief, undoubtedly hastens the end.

STRABISMUS.

Division of the ocular muscles is not done with the freedom of former years, and tenotomy and advancement are now regarded by most ophthalmic surgeons as the last steps in conjunction with other methods for gaining binocular vision, or for bringing a deviating eye to its natural position. Every condition of a squinting eye, viz., its acuity of vision, refraction, strength of muscles, and amount of deviation, should be accurately measured and known before any operative procedure is considered. Most ophthalmologists require their patients to wear correcting glasses, and to exercise, if necessary, weak muscles by the aid of prisms and otherwise, before advising operative treatment. The management of squinting amblyopic eyes requires much care and good judgment, because there is no incentive for such eyes to

remain straight. The muscles often act normally when the fellow-eye is closed, proving that there is no actual loss of power. These eyes will in some cases gradually recover their normal positions as the patients grow older, while in other cases the deviation may increase to the extreme limit. Tenotomy of the contracted muscle may not only fail to correct the defect, but may cause the eye to deviate equally in the opposite direction, wherefore it is probable that advancement will accomplish more in such cases than tenotomy; or it may be advisable to perform the operations on the opposing muscles, either at the same time or separately. When operative interference has been decided upon according to the characteristics of the case, we must decide whether it shall be tenotomy, advancement, or both. In cases of insufficiency, some surgeons (von Graefe, Abadie, and G. T. Stevens) have advocated partial or graduated tenotomies. When hyperphoria is present it is claimed that graduated tenotomies accomplish a great deal, for there is often much discomfort from even one or two degrees of deviation. Dr. G. T. Stevens, of New York, has devised special forceps and scissors for this mode of procedure. Cocaine is of inestimable value in this class of operations, as enabling the results to be seen as the operation progresses.

Tenotomy is still performed after the method described by Arlt, and by the so-called subconjunctival method. The advocates of the latter claim that it is attended by less exposure of the subconjunctival tissues and less likelihood of the caruncle sinking. *Advancement* is performed by making a vertical incision over the tendon, which is then raised upon a hook. A suture with two needles is now passed through the muscle just back of its junction with the tendon, when the latter is divided, and the conjunctiva is dissected from the first incision to the corneo-scleral junction. The muscle is next drawn forward and fixed in its new position by passing the needles through the conjunctival and episcleral tissues, and bringing them out, one above and one below the cornea. The ends are tied, both eyes are dressed antiseptically and closed by a bandage, and the patient is kept quiet in bed for several days. The sutures should be left in as long as they will hold without creating too much irritation. Prince's *pulley operation* is an ingenious method of advancing a muscle. A suture is introduced vertically, near the corneo-scleral junction, through the conjunctival and episcleral tissues, and the ends are tied, making a stationary loop. The muscle is next pierced back of the tendon by a needle carrying a suture, which after emerging is carried forward through the loop. The ends are then tied, and the advancement is regulated by tightening or loosening the thread. The objections to muscle advancement are the liability of the sutures tearing out and rendering the operation useless, the amount of irritation that is set up by the operation, the danger of wounding the ciliary body if the needles pass too deeply into the sclera, and the deformity that is caused by "bunching" the tissues. Landolt maintains that only by advancement can the normal movements be retained, and he rarely operates for insufficiency. He performs tenotomy with advancement upon the worse cases of strabismus, and declares that sutures do not tear out when introduced into the episcleral tissue.

TREATMENT OF EYE DISEASES BY SUBCONJUNCTIVAL INJECTIONS.

This method and that of the intra-ocular injection of certain drugs in solution have received considerable attention in recent years from Darier, Abadie, and others. It seems that the subconjunctival injection of drugs is to be preferred to the latter method, for it has been proved that the drug is as readily absorbed from below the conjunctiva as from Tenon's space, and that there is less liability of injury to the inner coats (choroid and retina) when these are not wounded by the needle. Darier says, in referring to the action of the bichloride or cyanide of mercury for wounds, "it acts as an antiseptic. . . . In general treatment it is often antisyphilitic; but it has also in many cases a bactericidal, microbicidal, antiseptic action which is of great importance." This mode of treatment is especially useful for syphilitic diseases of the eye, but has also been successfully tried in cases of iridocyclitis and sympathetic ophthalmia. Other drugs besides mercury have been employed for various diseases, but not with very favorable results, so that the method has finally narrowed itself down to using the soluble salts of mercury, of which the sublimate and the cyanide are the best. Darier rather favors the latter. He admits, however, that for bringing the patient quickly and thoroughly under the influence of the drug, no treatment can equal that by inunction, and especially when the subconjunctival injections are also used. For infecting ulcer of the cornea, no treatment is followed by better results, and in retino-choroiditis the improved condition is readily seen by ophthalmoscopic examination as well as recognized by the increase of vision. In affections of the optic nerve, only recent cases have improved. No benefit has followed when there has been gray spinal atrophy, while in white atrophy following inflammatory action there has been slight improvement. Darier says that "subconjunctival injections are contra-indicated, momentarily at least, every time that a circulatory stasis renders the absorption of the medicine difficult or impossible by the obstructed lymphatic passages." For this reason, in acute inflammatory processes of the iris and ciliary body, it is contra-indicated, and general treatment is to be preferred. Darier injects every day, or as often as circumstances require, five cubic centimetres of a solution which contains 0.005 milligramme of cyanide of mercury, the same amount of cocaine, and 0.035 milligramme of chloride of sodium. The sublimate may be used in the strength of 1 to 1000, and two or three minims are injected at a time. The injections may cause considerable pain and swelling, but the former subsides after an hour or two. Darier uses a Pravaz syringe with a platinum-tipped needle which can readily be sterilized in a flame, but any form of hypodermic syringe will answer if it is perfectly clean.

NOTE.—In the preceding pages I have drawn frequently from standard works on Ophthalmology, especially those of de Schweinitz, Fuchs, and Berry, and from journals both special and general. I have not always given credit for views and opinions expressed, but as the article is meant to supplement that written by Dr. Williams in Vol. IV., and not to contain the opinions of any one author, it has not been considered necessary to mention every name. When subjects have been omitted it has been thought that the original article was sufficient.

INJURIES AND DISEASES OF THE EAR.

BY

ALBERT H. BUCK, M.D.,

OF NEW YORK.

SINCE 1884, when the article on "Injuries and Diseases of the Ear" was written for the "International Encyclopædia of Surgery," the domain of aural pathology and therapeutics has been enriched in various directions. Thus, for example, we have reached, during these years, a more perfect knowledge of the intimate relationship between nasal and vault troubles and affections of the ear; and as a result of this increased knowledge I am warranted in saying that many a case is now rescued from more or less serious impairment of the hearing, which in those and still earlier days would have been dismissed as incurable. Then there is another large class of ear cases to which a great deal of attention has been paid during the last decade; I refer to those affected with chronic ulcerative disease of the invisible portions of the tympanic cavity—the *recessus epitympanicus* or the vault of the tympanum, the ossicles which occupy a part of this hidden vault, and the still more remote mastoid antrum. These are the cases which furnish the greater part of the mortality from ear disease, a mortality which—I am pleased to be able to say—is growing steadily less as the years go by. The diminution of this death-rate is due to the fact that we are now able to treat a large percentage of these cases successfully, relieving them of the foul discharge which almost always characterizes chronic disease of the vault of the tympanum, and removing from the immediate neighborhood of the brain a dangerous focus of disease. There are two ways by which these results are usually obtained: one, by the systematic cleansing of the vault of the tympanum with peroxide of hydrogen or with weak bichloride solutions forced through suitably bent glass or metal canulæ, the ossicles (if present) not being disturbed; the other, by the employment of precisely the same measures after first removing the hammer and anvil. In the majority of instances a faithful and intelligent employment of the first of these methods will effect the desired cure, but in a few cases, especially those in which the opening into the middle ear is small, the most skilful use of the slender probe and the most faithful employment of antiseptic intra-tympanic washes will not produce this result, and we shall then be justified in urging upon the patient ossiculectomy—as this operative removal of the hammer and anvil is termed.

The technical details of both this operation and that for the removal of the stirrup—stapedectomy—need not be given in this place; they

belong more properly in the special treatises on otology. I may state here, however, that while ossiculectomy has now won for itself an accepted position as a valuable therapeutic procedure in cases of chronic discharge from the middle ear, the value of both this and stapedectomy, in the treatment of non-purulent cases of middle-ear disease, has not yet been demonstrated.

Of the numerous remedies discovered during the last ten years a few have proved extremely useful to the aural surgeon. Perhaps the most conspicuous of these is the peroxide of hydrogen, a most useful intratympanic cleansing fluid. There are also several new remedies, in the form of powders, which have met with considerable favor at the hands of aural surgeons. It is still doubtful, however, whether any one of these can be assigned a higher place, in the scale of usefulness, than boric acid and iodoform.

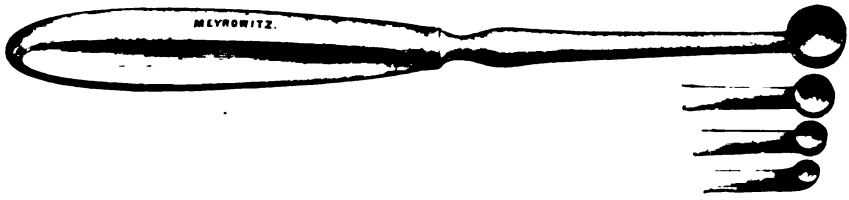
Finally, the technique of the mastoid operation is now well settled; the superiority of the chiselling over the boring method being almost universally admitted. In view of the limited amount of space which in this volume can properly be devoted to the discussion of otological matters, I propose to restrict myself almost wholly to the consideration of the topic last mentioned. Such a course, furthermore, commends itself to me with special force for the reason that the account which I have given of this operation in my previous article is in many respects faulty.

Technique of the Mastoid Operation.

Instruments Required.—The *cowhide mallet* sold in the instrument shops is every way more satisfactory than that of steel (with lead filling). It is a much lighter tool to handle, and yet with it the operator can readily force the chisel through the densest bone tissue. One can work more quickly with *chisels* than with gouges, and they are much easier to keep sharp. Six chisels of three different sizes—that is, of three different breadths at the cutting edge—and one or two small gouges will serve as an adequate supply. The broadest chisel should not exceed $\frac{3}{16}$ inch (about 5 mm.) in breadth, and the smallest of the three should have a breadth of a little over $\frac{1}{16}$ inch (2 mm.). The lower part of the chisel, down to the base of the cutting edge, should be quite thick (see Fig. 1703), so as to prevent any springing on the part of the instrument, and also so as to facilitate the sharpening of the cutting edge. Chisels for mastoid work should be kept very sharp. *Volkmann's spoons* (Fig. 1700), with broad and strong handles of hollow steel or aluminium, are extremely useful in removing the deeper bone tissue ordinarily encountered in mastoid processes. The bowls should have sharp cutting edges and should be of three different sizes, viz., about 8 mm., 7 mm., and 4 mm. in diameter. *Silver or hard-rubber canulas* about 4 inches in length, slightly bent at one extremity, and broadening out into a bulbous mass at the other (for the purpose of connecting it with the rubber tubing of some form of douche or syringe), are needed for irrigation purposes. Two sizes (2 mm. and a little over 1 mm. in diameter) are sufficient. The *mastoid hook guide*, pictured in Fig. 1701, serves the purpose of a trustworthy landmark, by means of which the operator can know, at any moment during the

progress of his work, whether he is on the right track toward the mastoid antrum—the goal which he is aiming to reach. The mode of using this instrument will be described farther on. Usually one *retractor* suffices, but in exceptional cases, where the mastoid integu-

Fig. 1700.

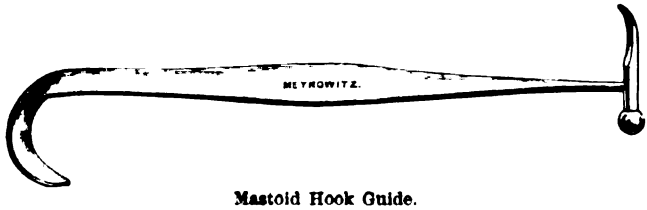


Volkmann's Spoons.

ments are greatly swollen, two may be found necessary. They should be made of steel, and the prongs should be so disposed as to press flatwise against the tissues (Fig. 1702).

This, I believe, concludes the list of special instruments needed in this operation. Besides these, of course, there will be needed a strong straight knife, a blunt periosteum elevator, an ordinary thumb forceps

Fig. 1701.

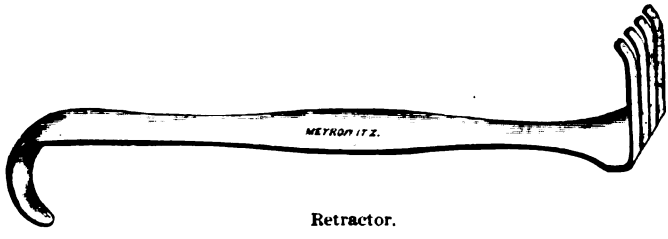


Mastoid Hook Guide.

for removing chips of bone, one or two Bowman's probes, seven or eight long and slender self-clamping artery forceps, and needles curved flatwise.

Preparations for the Operation.—In most cases it is necessary to shave off the hair for a certain distance above and behind the mastoid region, owing to the fact that it encroaches upon the very area in which

Fig. 1702.



Retractor.

the operator must make his incision; but in some persons this area is quite free from a growth of hair, and the shaving may then perfectly well be dispensed with, provided the case be one in which it is almost certain that operative interference will not go beyond the mere estab-

lishment of a free channel through the bone down to the antrum. But if there is the least doubt about the extent of operative interference that may be required, it is better to shave off the hair from the immediate neighborhood of the mastoid process and subject the skin surface thus exposed to a thorough scrubbing and disinfection. In the case of women with long hair it is not an easy matter to protect the latter from the blood and other materials that escape from the wound or from the ear. An elastic rubber cap, such as is worn by women bathers at the seaside resorts in France, furnishes the desired protection, but I have thus far failed to find these or similar caps at any of the rubber shops in this city. A folded towel, wrung out of a 1–2000 bichloride solution and wrapped firmly round the patient's head, makes a fairly good substitute. The rigid antiseptic precautions which are considered so very necessary in some other operations, are of less value in this. In nine cases out of ten we are engaged in the work of establishing a new and larger channel for the drainage of a focus of disease which is presumably sufficiently septic to undo all the beneficial effects of any attempt that we may make to render instruments, hands, cloths, etc., really aseptic. What is of much greater importance is to terminate the operation by the most careful efforts to cleanse and render aseptic not only the centre of the disease in the mastoid antrum or neighborhood, but also all the cut surfaces and adjacent skin.

The External Incision.—This should be made in a curving direction, very nearly parallel with the line of attachment of the auricle. It should begin at a point above and a little in front of the orifice of the external auditory canal, and it should end at the tip of the mastoid process. A margin of skin, at least half an inch in breadth, should everywhere intervene between the edge of this cut and the line of attachment of the auricle. The effort should be made, in this first incision, to carry the point of the knife through the periosteum, as well as through the skin, throughout the entire length of the cut.

Control of the Bleeding.—Pressure with the finger of an assistant, in the immediate vicinity of the wound, will usually control the bleeding sufficiently to enable the operator to proceed with the second step of the operation, viz., the separation of the periosteum from the underlying bone, over the outer and anterior surface of the mastoid, and just above the orifice of the osseous external auditory canal. After this has been accomplished, his first care should be to control, in some more permanent fashion, the bleeding—not so much on account of the possible weakening effects of the loss of blood, but particularly because he will require, from this point onward, as clear a view as he can obtain of the field of operation. If there are any spurting vessels, their mouths should be closed by means of artery forceps; and if troublesome oozing of blood still continues after the forceps have been applied, small hot sponges, squeezed as dry as possible after being removed from the hot sublimate solution (1–2000 or 1–3000), may be crowded into the wound and left there for three or four minutes. Still another effective method of controlling this general oozing of blood from numerous small vessels is to allow very hot water—as hot as the hand can bear for a few instants—to trickle from a sponge into the open wound, or to be injected into it by a suitable syringe. Ligation of the bleeding vessels is generally not necessary, and should be avoided in the

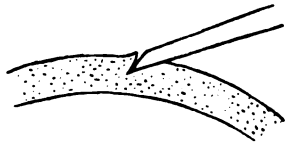
case of vessels situated in that part of the wound which is afterward to be closed by sutures. In the case of a weak person, or when the surgeon or a competent assistant cannot visit the patient within six or eight hours after the operation, the safer rule is to apply a ligature to the posterior auricular—the only artery that is large enough to furnish any considerable loss of blood. In a few cases the bleeding from the vessels in the substance of the mastoid bone, after the chiselling has laid bare the deeper cellular structure peculiar to this region, is quite copious. Hot water seems to exert very little influence upon this diffuse bleeding from vessels within the bone, and we may be forced to stuff the cavity with iodoform gauze and patiently wait for the bleeding to stop.

Landmarks that May be Used in Searching for the Mastoid Antrum.—When the bleeding from the soft parts covering the mastoid process has been stopped, the surgeon may proceed, without further delay, to cut away by the aid of chisels and Volkmann's spoons those portions of the bone which conceal from view the mastoid antrum. The exact location of this small cavity should be kept constantly before his mind's eye as he removes, bit by bit, the intervening bone substance. Without artificial help of some kind, this is no easy task. The best natural landmark, the curving edge of the entrance to the external auditory canal, is not constantly in view, owing to the presence of blood in sufficient quantity to conceal it. Then, too, the very first steps of the chiselling may so alter the picture as to make the operator feel that he must again and again take note of his bearings before he can safely remove more bone substance. What is needed, therefore, is some artificial landmark which shall always be visible to the operator, even when the average amount of bleeding is going on, which shall remain immovably fixed in the same position, and which shall not hamper the operator in any of his manipulations. The mastoid hook guide, pictured in Fig. 1701, answers these requirements in a fairly satisfactory degree. The retractor shown in Fig. 1702 is first applied to the soft parts constituting the anterior flap of the wound, and the whole is drawn well forward so as to bring the posterior and upper edge of the bony external auditory canal into view. Then the steel hook guide is to be hooked into the canal from above, between the soft parts and the bone, and the roughened tip of the hook is to be kept, by an assistant, pressed firmly against the upper wall of the canal. The round knob of steel on the convex side of the hook will then be found to stand up conspicuously in front of the area of bone surface which is to be removed by chiselling. The sides of the pit which the operator is about to make in the bone should converge toward a point seemingly situated directly behind this knob of steel; or, to speak more correctly, toward a point in a transverse vertical plane which runs parallel to one passing through the steel knob, and which, at the same time, is only a short distance (from ¼ to ½ inch) from it. The use of the word "behind" has reference, of course, to the relations which exist when the body is in the vertical position, and the assistant who holds the hook in position can facilitate the operator's estimate of these relations by keeping it constantly in the line of the vertical axis of the patient's body.

The Proper Mode of Using the Chisels and the Volkmann Spoons.—Two or three simple rules will suffice to guide the beginner in his em-

ployment of these instruments. In the first place, the chisel should not be held at or near a right angle to the surface of the skull, but in such a a manner as to form an oblique angle with it (Fig. 1703). The bevelled edge should be kept uppermost. It is safer to remove the bone in small chips. Light blows of the mallet, frequently repeated, are better than a few heavy ones. When softened bone, or the cellular bone structure peculiar to the central part of the mastoid process, is reached, Volkmann's spoons will be found more efficacious and safer than the chisel. Frequent probing of the sides and bottom of the excavation is a very necessary procedure, if the operator wishes to get early information of the proximity of the lateral sinus, of an abscess cavity, or of the mastoid antrum. On reaching the latter the surgeon should take particular care not to push any stray chip or fragment of bone into the middle ear. It is scarcely possible to lay down any fixed rule in regard to the amount of bone substance that should be removed at the operation: surgeons are unanimous in regard to the necessity of removing all carious and softened portions of bone tissue. A few authorities insist upon the desirability of cutting away, in the majority of cases, a large part of the tip of the mastoid process, as otherwise a separate and isolated collection of pus in this part of the bone may be overlooked. Such a rule seems to me to be too sweeping in its character. It is enough, it seems to me, if we restrict the adoption of this plan to those cases in which the symptoms, before the operation, have pointed to the spread of the mastoid inflammation to the tissues along the side of the neck. In all other cases we shall have done all that is required of us when we have established a broad channel down to the mastoid antrum, and have removed all bone substance that is carious or that seems to be unnaturally softened.

Fig. 1703



Mode of Applying Chisel to Mastoid.

Dangers of the Operation.—The possible wounding of the lateral sinus is the only serious danger that may be encountered. But only a reckless operator is likely to seriously injure this fairly tough vein when it is not softened by disease. If, however, its wall has been thinned in consequence of ulcerative action, it may easily be broken through by even a careful operator. On the other hand, the wounding of the facial nerve in the vicinity of the antrum is an accident that may very readily occur. It is therefore important not to indulge in instrumental manipulations, scraping the bone, etc., in this cavity, unless we are perfectly sure that such interference is necessitated by the carious condition of the part. What I have said in regard to the lateral sinus, applies equally well to other portions of the dura mater; the danger of wounding it is small.

Opening into the Groove for the Lateral Sinus, or into the Cranial Cavity at Some Other Point.—When, in the course of the operation, carious or even blackened bone is encountered, it is our clear duty to remove it, even if by so doing the dura mater or the wall of the lateral sinus be exposed to view. But it is not so easy to formulate any definite rule about laying bare the lateral sinus in cases in which carious bone or blackened bone (that is, bone in which venous stasis has taken place) is not encountered in the course of the ordinary mastoid oper-

ation. In the presence of bone tissue that is only moderately congested, and in the absence of any other evidences of inflammatory action along the course of the jugular vein, we should certainly not be warranted in opening into the sigmoid fossa. But if the substance of the mastoid bone is found to be highly congested, and if it bleeds copiously from all the surfaces cut with the chisel or with Volkmann's spoon, we have a right to assume that a certain amount of periphlebitis must exist in the sigmoid groove surrounding the lateral sinus ; but from this circumstance alone we are not warranted in believing that this periphlebitis has reached the purulent stage. If, however, the tissues beneath and behind the mastoid process are considerably infiltrated at the same time, we may confidently assume that the periphlebitis has gone on to the point of filling the space between the vein (lateral sinus) and the surrounding bone with pus, and we may proceed without hesitation to make an opening into this space and afford an outlet for the imprisoned fluid.

At this point another question arises, namely, whether we shall remove the rest of the mastoid process so as to obliterate entirely the bony channel through which runs the jugular vein from the sigmoid fossa down to the side of the neck; or whether we shall rest satisfied with the establishment of a simple opening for drainage, as described above. In the few cases in which this question has arisen I have referred the matter to a general surgeon, and in each instance the removal of all this mass of bone has been advocated, on the ground that in no other way could we be sure of preventing the encagement of pus at some point along this tortuous channel.

Final Steps of the Operation.—Thorough irrigation of all the cavities and recesses of the antrum and middle ear proper is a matter of great importance in all chronic cases. As long as any decomposing cheesy material or other source of irritation is allowed to remain stowed away in some nook or corner of the tympanum or communicating cavities, just so long may we expect the old discharge from the ear to continue, in greater or less quantity. A weak, lukewarm bichloride solution (1–4000 or 1–5000) is perhaps as good as any other for irrigating purposes. When the solution injected through the wound into the antrum, by means of one of the canulas already described, ceases to bring away débris, and escapes from the wound or from the external auditory canal in a perfectly clear condition, the surgeon must be careful not to draw the inference that he has washed away all offending material from the middle ear. He should make repeated use of a slender silver probe, bent at the knobbed end, in the hope that he may in this way loosen masses which the stream from the canula has failed to dislodge. If, after two or three trials of this nature, he finds that the escaping fluid still remains clear, he may safely infer that he has accomplished the task which he set out to perform. It is not a matter of any importance whether a bulb syringe or a gravity douche be used in connection with the long slender canula. In the acute cases, where the inflammation has developed in a previously healthy tympanum, the irrigation of the cavities of the middle ear is unnecessary. They contain nothing but laudable pus, which is harmless if it be provided with a free outlet; and there is always danger, if we irrigate under these circumstances, of washing into the middle ear some small chip or frag-

ment of bone that will lodge there and materially delay the ultimate healing. On the other hand, the outside wound and the excavation in the mastoid bone should in every case receive the most thorough washing with the bichloride solution.

Opinions differ in regard to the question whether the outside wound should be left entirely open or be partly closed by sutures. Very few, I think, would venture to entertain the hope of securing primary union of the lips of the outside wound throughout its entire extent; but there are some who advocate the policy of keeping the parts in such a perfectly aseptic condition that healing shall take place almost without the formation of pus. I am quite ready to admit that there are some cases in which this plan may perfectly well be adopted, but I think it will be found safer, in the long run, to permit a certain amount of pus-formation to accompany the granulating process. Have we not facts in our possession, especially in the medical literature of former times, which justify us in believing that such a discharge, if kept within reasonable bounds, exerts a curative effect upon any deeper-seated inflammation that may still be smouldering in the vicinity? As regards the question whether the wound should be left entirely open or not, I do not believe that any fixed rule can be laid down. I almost always apply sutures to the upper horizontal portion of the wound, but in quite a number of instances the early occurrence of a chill, with a marked rise in temperature and perhaps a return of the pain, has compelled me to remove them and restore the wound to its gaping condition. In all or nearly all of these instances the mastoid integuments, at the time of operation, have been a good deal congested and infiltrated. In this class of cases, therefore, I have at one time or another followed three different plans, and I cannot say which is most to be commended, as I have had reason at times to be dissatisfied with all of them. One method is to introduce one or two silver sutures in the horizontal portion of the wound and tie them very loosely, with the expectation of tightening them properly after the swelling and inflammation of the skin have subsided. In some cases this plan works satisfactorily, while in others the presence of the sutures seems to perpetuate the irritation and infiltration of the skin through which they pass. A second method is to leave the entire wound gaping until the skin has nearly returned to its natural condition, and then, after scraping away all intervening loose granulations, and washing the parts thoroughly with a fairly strong (1–2000 or 1–3000) bichloride solution, to bring the edges of the horizontal portion into accurate coaptation by means of the ordinary silk sutures. There is only one objection to this plan; it involves the infliction of considerable pain, or the brief administration of an anæsthetic, both of which are unpleasant things for the patient. The third plan leaves out sutures altogether. The wound is allowed to heal by granulation, and the edges are coaxed together by the use of a pad applied against the auricle and kept pressing backward and upward by means of a bandage. The most serious objection to this method is this: a slight drooping of the auricle—recognizable, it is true, only when the patient's face is closely scanned from in front—may be left as a permanent result. In patients of the male sex this slight lack of symmetry is a matter of no great importance, but in women it is scarcely permissible to leave any recognizable deformity of this nature.

The After-management of the Wound.—During the first twenty-four hours following the operation there is apt to be a somewhat active oozing of bloody serum from the wound, and special provision should be made to catch this abundant escape of fluid. A pad composed of several thicknesses of iodoform gauze is first laid over the wound, and then over this is placed a large mass (a double handful) of absorbent cotton. A few turns of a gauze bandage, carried from the back of the neck over the forehead, will keep the whole firmly in position. It is not usually necessary to leave a drainage tube in the wound. The only thing that may render this desirable is the discovery, after the horizontal part of the wound has been sutured, that the anterior flap completely overlaps the posterior edge of the excavation in the bone, and so threatens to interfere with the free escape of discharge from the deeper parts of the ear. In anticipation of this difficulty, it has been my rule, in recent years, to cut out a shallow groove in the surface of the mastoid bone, from the posterior edge of the excavation backward to the posterior edge of the wound in the skin. This supplies all the mechanical requisites of a drainage tube, and greatly facilitates the introduction of a canula for irrigation purposes. When the skin surrounding the wound looks red and tense, wet applications will be found the most suitable. A soft linen pad, saturated in a wash composed of one part of alcohol to three parts of a 1–3000 or 1–4000 bichloride solution, will be found to answer well the desired purpose. The pad should receive a fresh wetting every half or three-quarters of an hour; and when bedtime comes, a dry dressing (a pad of iodoform gauze and some absorbent cotton outside of it, with a light head bandage to keep the whole in place) may be substituted for the night. In most cases, irrigation of the excavation in the bone may be entirely dispensed with after the third, fourth, or fifth day, and the wound may be then treated in all respects as if it were an ordinary wound on the surface of the body.

DISEASES AND INJURIES OF THE NOSE AND ITS ACCESSORY SINUSES.

BY

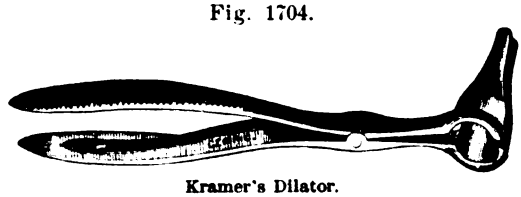
RALPH W. SEISS, M.D.,

PROFESSOR OF OTOLOGY IN THE PHILADELPHIA POLYCLINIC.

EXAMINATION AND INSTRUMENTS FOR GENERAL TREATMENT.

INNUMERABLE new instruments and methods have been devised during the last ten years, but only a few are valuable enough to demand special mention. The electric light, used either as a small incandescent lamp introduced directly into the mouth or nose, or attached to the head band in place of a forehead mirror (Trouvé's apparatus), has come into quite general employment. The hand lamp is of great value in the diagnosis of diseases of the antrum, but the head light has the great disadvantage of giving a narrow light line in the centre of the field, the surrounding area being insufficiently illuminated. Its use is mostly confined to cases in which ether anæsthesia is required, and in which an exposed flame is of course inadmissible. Numerous portable batteries are on the market, the storage battery having perhaps the preference.

Fig. 1704.

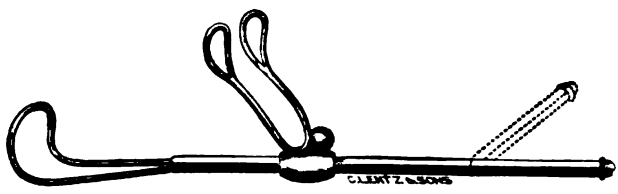


Kramer's Dilator.

The older forms of spring specula have been very largely abandoned, and some modification of Kramer's dilator is now almost universally employed by rhinologists. (Fig. 1704.)

Since the general use of cocaine, palate hooks are much more valuable than formerly, and some one of the various late models should form a part of the rhinologist's outfit. The self-retaining hook of White, of Richmond, is one of the best for general purposes. (Fig. 1705.)

Fig. 1705.



White's Palate Hook.

In the general treatment of nasal diseases the fine spray atomizer and delicate syringe have almost entirely superseded grosser instru-

ments and the use of powders. A pressure of from ten to twenty pounds is used by the majority of rhinologists, and the employment of so great a force as "forty pounds or more to the square inch" has been almost wholly abandoned as irritating and injurious. Medicated powders have been less used than formerly, and I do not myself employ them except to stop hemorrhage or cover an ulcerated surface.

The whole treatment of nasal diseases has become much more gentle and conservative, the great injury to the Eustachian tubes, middle ears, and accessory sinuses of the nose, and the remote ills resulting from many lauded measures, having necessitated such a change.

Antiseptic surgery has been as valuable in nasal operations as in those on other regions of the body, but the possibility of rendering or keeping the fossa sterile is more than doubtful. Surgical wounds are treated almost exclusively by the "open method," dependence being placed on antiseptic irrigation and dusting powders used once or many times a day. A very ingenious method of using the "closed dressing" has been devised by Roe, of Rochester, N. Y.,[1] consisting of plugs made of "thin metallic plates, evenly, carefully, and firmly wound with antiseptically prepared Angora wool or bichloride cotton, and which before being introduced are dipped into a solution of bichloride of mercury (1 to 3000). The metal plugs should be of such size and shape that when wound with cotton and inserted in the nostril they completely cover the wounded surface." This or any other "closed method" is thought by most rhinologists to produce more irritation than the amount of sepsis uncontrollable by proper and thorough open treatment.

Coryza or Rhinitis.

Acute Coryza.—But little has been added to our knowledge of the pathology of this disease, the most important points being the demonstration of its causative relation to acute otitis and inflammation of the frontal and other sinuses.

The *treatment* of an acute rhinitis has, however, been made much more satisfactory by the introduction of such new drugs as cocaine and menthol, and by improved methods of application. A "cold in the head" may often be aborted in its early stages by the following method: From three to five drops of a five-per-cent. solution of cocaine muriate are first injected into each nostril by means of an ordinary medicine dropper. Complete contraction usually results in from five to eight minutes, thoroughly opening up the nasal chambers, and permitting the otherwise impossible, thorough use of an antiseptic spray. The latter is to be gently but thoroughly used until the fossæ are absolutely free from mucus and débris; I commonly employ a solution of boric acid, borate of sodium, and chloride of sodium, but Dobell's solution and compounds containing Listerine are perhaps equally valuable. After thorough cleansing, the membrane should be freely coated with a spray of liquid albolene containing from three to five grains of menthol and camphor to the ounce. Very frequently the coryza will wholly disappear, not to return, after the above-described treatment, and in all cases it will be found to run a much shorter and milder course than

[1] Medical News, March 28, 1891.

if left to take care of itself. If the patient is not seen until infiltration has progressed, the same sprays may be used with some benefit, but the cocaine should be omitted, as at this stage it seriously lowers the tone of the membrane and aggravates and prolongs the disease. It is during the stage of acute vascular distention that the alkaloid acts most happily. The use of menthol as an inhalant is of much value all through the course of the disease. The "inhalers" employed are well known to the drug trade, and consist of glass tubes filled with menthol crystals, which are confined by two perforated discs of metal or fibre. The end of the tube terminates in a cone, which is introduced into the nostril during inspiration, the menthol fumes being thus drawn into the nose. A sensation of coolness and comfort is produced, very satisfactory to the patient; the inhalation may be used as frequently as may seem desirable. Much of the sedative treatment which will be discussed under hay fever applies equally to an attack of ordinary acute coryza, and may be used with benefit in the latter disease. Internally, a dose of about $\frac{1}{12}$ grain of morphine may be given at bedtime along with a hot whiskey lemonade, and will complete the cure in many instances.

Quinine, although occasionally useful, is a remedy which I seldom employ, as its use greatly increases the dangers of Eustachian salpingitis and middle-ear complications. After a "cold" has become established sodium bromide may be given in full doses, and seems to shorten the attack while it certainly adds to the comfort of the patient. Tincture of euphrasia in ten-drop doses has been highly recommended by G. M. Garland, but has given less satisfactory results in other hands. Beverly Robinson gives carbonate of ammonium "in frequently repeated and tolerably large doses." In long-continued attacks tonics are often needed, strychnine and a reliable wine of coca being especially valuable.

Complications from extension of the disease to the Eustachian tubes, frontal sinuses, larnyx, etc., demand close attention and appropriate treatment, and make up the dangers of an attack of acute coryza, the complication often developing after the nasal inflammation appears to have nearly run its course.

IDIOSYNCRATIC CORYZA.—Numerous elaborate papers have been contributed to the subject of "hay fever," adding greatly to our knowledge of both the pathology and the treatment of this disease. The causes of the paroxysms have been proved to be central or peripheral neuroses, which may be excited by a great variety of irritants, internal or external, physical or mental. As MacDonald[1] puts it, "the sneezing, lachrymation, rhinorrhœa, and swelling of the inferior turbinated bodies are but physiological symptoms produced in individuals whose *nerve-terminations* or *nerve-centres*, from pathological or other reasons, are of a peculiarly sensitive nature." The predisposing cause being a functional derangement of the nerve-centres (J. W. Mackenzie), the local phenomena may be produced by any irritant acting either on the nasal mucous membrane or on the central or peripheral nervous system. The most common local irritants are the pollen of grasses, of the ragweed, and of roses; almost any form of dust will bring on paroxysms in very sensitive subjects. As I have elsewhere shown,[2] such purely mental

[1] Diseases of the Nose, 2d edition, p. 219.
[2] Paper read in the Section of Laryngology, American Medical Association, 1892.

factors as anxiety, fright, or anger, as well as mental overwork, also frequently bring on typical attacks. The disease has been aptly named vaso-motor coryza, and occurs almost solely in "nervous" patients with ill-controlled vaso-motor centres, who complain of troublesome cardiac action, profuse perspirations, sensations of numbness in the limbs, cold extremities, etc. Idiosyncratic corzya is therefore regarded as essentially a nervous disease, demanding both peripheral and general treatment.

The results of examination of the nose are not conclusive. The ordinary symptoms of acute coryza are present during the acute attack, and any of the lesions of chronic rhinitis may also be found. In long-standing cases the inferior turbinated bodies frequently present a remarkable pallor of surface.

Treatment.—The therapeutic management of typical cases of hay fever is divisible into that proper for the attack, and the methods which may be used during the intervals to prevent return of the disease. A sufficiently strong solution of cocaine will nearly always relieve a paroxysm for a limited time; but the alkaloid ultimately rather aggravates than relieves the local disease, and is invariably followed by more or less constitutional poisoning and serious results. Used only occasionally as an adjuvant to more radical measures, simply to tide the patient over the height of the attack, cocaine has a legitimate field of usefulness in this disease. The solution used must never exceed ten per cent. in strength, and four per cent. is sufficient for many cases; the applications should not be made oftener than two or three times in the twenty-four hours. The solution is best applied by the ordinary medicine dropper, the patient bending the head backward and injecting a few drops of the fluid into the nasal chamber; frequently only one side will require anæsthetizing to secure relief.

Menthol stands next in value to cocaine as an agent for the relief of acute paroxysms. It may be used as an inhalant as described under acute coryza, or as a spray dissolved in fluid albolene—the strength in the latter case should range from four to ten grains to the ounce, as may be best suited to the individual case. Cubeb cigarettes give great comfort to a few patients, the smoke being allowed to escape from the mouth through the nostrils; from three to five may be allowed each day. Aqueous nasal sprays usually act as irritants during the height of the attack, but sedative inhalations through the mouth, on the other hand, often act well in allaying irritation of the lower respiratory tract. Such minor points as the wearing of blue glasses in the sunlight, and a respirator when dust is to be encountered, together with the use of gossamer veils whenever possible, often make up the difference between absolute wretchedness and comparative comfort to the patient.

MacDonald recommends the opium pipe, a few whiffs being sufficient, and speaks in the highest terms of chromic acid, finding it the most valuable local remedy.[1] He uses it in the form of "a spray of very weak chromic acid, $\frac{1}{8}$ to $\frac{1}{16}$ of a grain to the ounce of water. This should be sprayed warm into the nose for five minutes three or four times a day, according to the severity of the case and the relief experienced."

Among the many internal remedies which have been lauded as

[1] Diseases of the Nose, p. 239.

valuable in the acute stage of idiosyncratic coryza, morphine is the most reliable. From $\frac{1}{16}$ to $\frac{1}{12}$ grain of morphine sulphate may be given twice or oftener per diem, and will insure comfort in many cases; for evident reasons it should be given as little as possible. Atropine, antipyrine, asafœtida, and valerian have their advocates, but in the hands of specialists seem seldom to give relief at all commensurate with their drawbacks. Tonics, stimulants, and nutrients are very often indicated, and the mode of life should be as hygienic as possible. Climatic change to a high elevation or barren sea-coast, or such as is given by a long sea voyage, often offers the only hope of relief in severe examples of the "pollen cases."

During the interval between the attacks, a hay-fever patient should receive careful and appropriate treatment for any form of nasal disease which may exist. If any form of chronic rhinitis be present it must be cured: any serious obstructions to respiration, whether ecchondroses, bony spurs, or polypi, must be removed; and all hyperæsthetic areas should be carefully searched for and cautiously cauterized.

The discovery and destruction of these sensitive areas in purely "pollen cases" may be said to comprise the successful treatment of the disease. They should be sought for by careful probing under full illumination and inspection, and are not usually very difficult to localize by the starting, sneezing, or other evidences of unusual irritation given by the patient, even without his verbal statements. The anterior portions of the septum and the anterior region of the middle turbinated body are the most common situations of the sensitive spots. When localized, the area should be lightly seared with the cautery point, great care being taken not to burn too extensive an area or to interfere seriously with the blood supply. If every area of abnormal sensibility can be found, and the nerve-endings destroyed, there will be no return of the paroxysms in at least fifty per cent. of the purely pollen cases.

In regard to the "central" vaso-motor cases, space forbids a proper consideration of their treatment, which frequently comes within the province of the neurologist rather than of the surgeon. The patient requires treatment more than the local disease, and such measures as well chosen climatic changes, rest, systematic outdoor exercise, regulated bathings, general faradization and massage, are commonly much more valuable than surgical procedures. Local treatment has at least a palliative action, and may act also by transmitting favorable influences to the medulla; the various medical measures above mentioned are indicated, and any special source of irritation must be removed.

Other neuroses, especially of the eyes, larynx, and bronchi, may exist in hay-fever cases and be more or less dependent on the nasal disease. Their cure depends on the early removal of the cause by proper means, medical or surgical.

CHRONIC RHINITIS.—Although extensive contributions have been made to our knowledge of both the pathology and the treatment of this group of diseases, the general aspect of the subject remains the same. Perhaps the most important advances have been in the establishment of the direct etiological relationship between chronic coryza and many, or perhaps most, diseases of the ears, larynx, and bronchi, and of the eyes in many instances. Practically all cases of otitis media are now known

to depend on nasal disease.[1] Chronic laryngo-bronchitis, with its many complications, has a similar starting-point in most instances; and many ocular neuroses, as well as most diseases of the lachrymal duct, are now recognized as being directly dependent on chronic rhinitis of one or other of its many types.

Treatment.—Recognizing the high physiological importance of the nasal membrane, and its intimate association with various remote conditions, nasal therapeutics has become much more conservative than formerly. Destructive procedures are now seldom used for minor conditions, and are never employed in any condition where more moderate treatment will at all suffice.

Simple chronic coryza is almost universally treated by sprays combined with proper hygienic management. In addition to the standard solutions mentioned in Dr. Lefferts' article,[2] resorcin (5 grains to the fluidounce), the distillate of hamamelis, and boric acid (10 grains to the fluidounce), are extensively used by rhinologists, either alone or in various combinations.

Powders have been very generally abandoned, as causing far more irritation than benefit, and medicated bougies are rarely if ever employed in this disease by American specialists. Depletion by plunging a small tenotomy knife into the congested turbinated tissue has been recommended by Daly,[3] and lately by MacDonald of London, but has not been generally adopted. General measures directed to the vasomotor system are of great value in many instances, and cases in which the disease depends on a gouty or other diathesis demand special treatment directed to the constitutional condition.

Chronic hypertrophic rhinitis has been shown to be a disease of very various types, but generally divisible for therapeutic purposes into two stages, (*a*) vascular dilatation with hypertrophy; (*b*) complete hypertrophy or sclerosis.[4] The former type is treated as simple rhinitis, with the addition of various surgical measures to relieve stenosis. The measures fully described in Dr. Lefferts' article are still universally employed, but destructive agents are less used than formerly. The introduction of cocaine has made practicable many delicate procedures scarcely possible before it came into use, and its almost universal employment may be regarded as one of the greatest modern advances in nasal surgery.

In early and vascular hypertrophies great benefit frequently results from the use of Hubbard's nasal-dilator bag. The instrument consists of a violin-shaped rubber bag, 2¼ inches long and ⅝ inch wide at the extremities. The bag ends in a short rubber tube, through which a straight catheter is passed to the head of the dilator, and the end of the tube is tied firmly around it; the catheter is fitted to a half-ounce syringe in any convenient manner. To use the instrument, it is wet with Dobell's solution and slipped, while in a collapsed state, into the nasal fossa; when over the point of distention, the syringe, filled with tepid, hot or cold water, as may best suit the indications, is fitted, and the bag is dilated with any desirable amount of pressure for from one to five minutes. The engorged sinuses are thus emptied without either

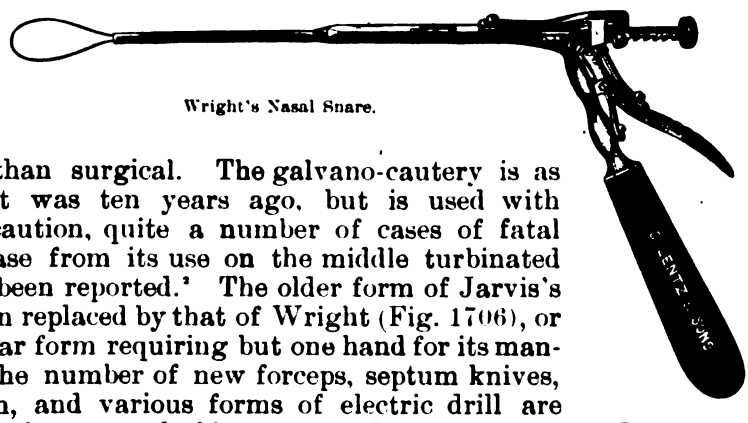
[1] Swinbourne, Medical Record, August 6, 1892.
[2] Vol. IV, *supra*.
[3] Medical and Surgical Reporter, Nov. 17, 1886.
[4] See paper by the author, Amer. Jour. Med. Sciences, February, 1889.

irritation or reaction ensuing, and the results are most satisfactory in many instances. The treatment may be repeated several times a week, or even daily in some cases.

Among the newer agents for the reduction of hypertrophies which will not yield to milder measures, trichloracetic acid has been very highly lauded.[1] The eschar produced by its application is particularly dry and clean, and the resulting irritation is less than with almost any other agent.

In the second stage of hypertrophic rhinitis, stimulating and alterative sprays and pigments are still of much value, and should always be given a fair trial; the hyperplastic tissue, however, often fails to yield to any measures other than surgical. The galvano-cautery is as popular as it was ten years ago, but is used with much more caution, quite a number of cases of fatal cerebral disease from its use on the middle turbinated body having been reported.[2] The older form of Jarvis's snare has been replaced by that of Wright (Fig. 1706), or by some similar form requiring but one hand for its manipulation. The number of new forceps, septum knives, etc., is legion, and various forms of electric drill are much used for the removal of bony or cartilaginous masses. Regarding the necessity of operation upon posterior hypertrophies, Harrison Allen[3] has shown it to be rarely called for, and regards it as a good rule to suspend operative treatment until all other morbid conditions have been carefully corrected.

Fig. 1706.



Wright's Nasal Snare.

Hypertrophy of the pharyngeal tonsil has received a large share of the attention of rhinologists during the last few years. By some the condition is regarded as a most formidable malady, responsible for very many of the diseased states of childhood and adolescence. Others, among them myself, believe the enlargements to be a serious menace only when of large size, and when associated with widespread inflammation of the upper air-passages. The greatest danger of post-nasal adenoids is to the organs of hearing, many cases of catarrhal deafness being dependent on the pressure upon and obstruction of the Eustachian tubes caused by the growths. The lungs, throat, and general development also suffer in many instances, and the characteristic stupid face and nasal deformity are soon established.

As to treatment, many believe, as I do, that early cases can often be satisfactorily cured by post-nasal applications of glycerite of iodine, *combined with thorough and well-chosen treatment of the whole naso-pharyngeal tract.* More advanced stages of hypertrophy, obstructing respiration, call for partial or complete removal, either by the methods already suggested or by the use of Gottstein's curette, which is now the favorite instrument for the purpose. Operative measures may be

[1] Killian, Münchener med. Woch., No. 39, 1891.
[2] Münch. med. Woch., No. 51. [3] University Med. Magazine, August, 1890.

very easily overdone here as elsewhere in the naso-pharynx. The neoplastic glands may take on sarcomatous changes, speedily terminating the life of the individual, apparently as a result of too energetic treatment.[1] Hemorrhage may be alarming and difficult to arrest, or serious Eustachian salpingitis and purulent otitis, with any of its complications, may result from too heroic surgery. Chronic atrophy of the pharyngeal tonsil with its annoying and almost incurable symptoms may also be brought about by the radical ablation advocated in certain text-books. The subsequent treatment of all operative cases is of the greatest importance. The pharyngeal vault should be carefully washed out at least once a day with some mild antiseptic solution, such as Dobell's, with double the usual amount of carbolic acid, and the same precautions as to exposure, etc., should be observed as after any minor operation. In my practice a fine silver Eustachian catheter fitted to a half-ounce syringe is used to wash out the vault, a delicate jet being thrown upward behind the palate after introducing the catheter through the mouth. Much of the danger of subsequent otitis is thus obviated, and healing is much more rapid and satisfactory than when no such measures are employed.

ATROPHIC RHINITIS.—The final stage of "hypertrophic catarrh" is now considered a form of atrophy as well as the more typical "ozæna." The former condition, better named *sclerotic rhinitis*, is characterized by marked thinning of the turbinated tissue with wasting of all the structures of the nose, the glands and venous sinuses being gradually replaced by fibrous tissue. The surface of the mucous membrane is light colored and rugose, and papillomatous changes are common; but erosions, epithelial desquamation with consequent crust formation, and involvement of bone, rarely occur. But little can be done for this form of nasal disease. Alterative sprays, local faradization, massage, and similar measures, frequently give relief to the symptoms, but a cure cannot be expected.

True ozæna probably depends on the presence of a rhino-bacillus, described by Marano[2] and Loewenberg; it is a capsulated form and diminishes in abundance proportionately with the institution and efficacy of antiseptic treatment. Ozæna is characterized by rapid atrophy of all the intra-nasal tissues, including the turbinated bones; the cavities become greatly enlarged, and the epithelial layer becomes non-ciliated. Crust formation and extensive erosions consequently occur, and the patient being unable to clear the nose, decomposition and the consequent ozæna stench are developed. The most important additions to the therapeutics of this disease are the employment of europhen and allied compounds, massage, and the local use of the faradic current. Europhen[3] may be used either in the form of powder, or as an ointment of five-per-cent or ten-per-cent. strength. In the latter case its use is advantageously combined with massage. A straight, firm cotton holder is tightly wrapped with cotton at its extremity so as to form a pointed cylinder about one inch in length; the tuft is then well charged with the europhen ointment and intro-

[1] Delie, Revue de Laryngologie, No. 18, 1891.
[2] Arch. de Laryng., de Rhin., etc., Avril, 1890.
[3] Therapeutische Monat., September, 1891.

duced into one nasal chamber. The "massage" consists of a quick, uniform, rubbing motion, the cotton cylinder being pressed somewhat firmly against the mucous membrane, and the entire surface subjected in turn to the friction. The sittings may occupy from two to six minutes, the patient being given brief intervals of rest between; great care is requisite, and the occurrence of hemorrhage is a very unfortunate accident, the dense clots greatly aggravating the nasal crusting. Faradism is of much value in all cases of rhinitis cirrhotica. The positive pole is applied directly to the membrane by means of the long nasal electrode, and the negative is placed over the antrum or is held in the hand of the patient. A moderate current should be employed, and the sittings should occupy from six to ten minutes, two or three times a week.

TUMORS OF THE NOSE.

This subject has been lately largely cleared of the haze of unscientific uncertainty which for years has clouded it. I have adopted the following classification after somewhat extensive microscopical study of the subject.[1] Leaving aside the true malignant growths, and certain mixed tumors, both of which occur in the nose as in other mucous membranes, four types of local new growth are found in the nasal chambers: (1) *Angeiomata* (telangiectatic degeneration). (2) *Adenomata* (glandular hyperplasia). (3) *Myxomata* (mucous degeneration). (4) *Papillomata* (dendritic epithelial tumors). Adenomas and myxomas, the latter being often but a degenerative stage of the former, are the ordinary "mucous" or "gelatinoid polypi" so common in the nasal cavities. The minute structure of nasal pseudo-adenomata resembles in all details that of the true neoplasm, viz., a fibrous-tissue matrix containing numerous tubular glands lined by epithelium. The connective tissue is exceedingly vascular, and extensive inflammatory small-cell infiltration is always present. Myxomata contain very little connective tissue, being composed of a few stellate cells holding in their meshes structureless mucoid tissue.

Papillomata of small size are very common in the posterior nasal region, resulting, like this form of neoplasm generally, from prolonged irritation of the epithelial layer.[2] Vascular degeneration of turbinated tissue—pseudo-angeioma—is occasionally found; the boggy, very vascular masses are usually situated at the anterior end of the middle and lower turbinated bodies.

In the surgical removal of these growths, comparatively little has been added to our previous knowledge. Electrolysis is frequently used, and is said to be effective even in the case of cartilaginous outgrowths;[3] the bipolar method has been advocated by the latest investigators. The perfection of the galvano-cautery has made the radical treatment of nasal polpyi much more certain. The point of attachment should be thoroughly seared in most cases; polypi which come from beneath the middle turbinated body are followed up to the hiatus semilunaris by Casselberry, by insinuating a fine electrode slightly curved on the flat;[4]

[1] University Med. Magazine, Jan., 1892. [2] Amer. Jour. Med. Sciences, Feb., 1889.
[3] Bergoine et Moure, Arch. de Chirurgie de Bordeaux, Nos. 3 et 4, 1892.
[4] New York Med. Jour., No. 20, 1891.

and those which spring from the superior meatus posteriorly are reached by a curved electrode introduced through the mouth. In very exceptional cases a cure can only be secured after removal of the anterior-inferior extremity of the middle turbinated body, by means of curved serrated scissors or a powerful snare.

A large number of cases of malignant growth of the nasal region have been reported during the last few years in medical literature. The general aspect of the subject remains, however, practically unchanged, and the surgical principles and technique involved belong to the province of the general surgeon.

Nasal Neuroses.

These bear an important part in clinical medicine, it having been established by scores of independent observers that the highly sensitive nasal lining may affect reflexly many other organs. Eye symptoms, such as asthenopia, contraction of the visual field, ocular pain, subjective color sensations, and infra-orbital neuralgia, are very frequently due to intra-nasal conditions, and are only curable by treatment of the nose. Inflammatory eye affections, such as catarrhal and follicular conjunctivitis, blepharitis, and obstruction of the lachrymal duct, are also lesions commonly cured by removal of the causative nasal disease.[1] Urinary incontinence, cardiac neuroses, bronchial asthma, and various phases of neurasthenia, are almost daily relieved by the rhinologist by intra-nasal measures. Treatment must always be of the most gentle and conservative type to secure good results, for, as Beverly Robinson has very aptly pointed out,[2] indiscriminate surgical measures may increase or even originate the very conditions which they are designed to relieve, by the formation of cicatricial tissue and by reflecting irritation.

Diseases of the Accessory Sinuses of the Nose.

These are at present treated upon quite different lines from those followed a few years ago.

The *frontal sinus* is probably inflamed in all cases of severe acute coryza, and pus accumulations in it are much more common than was formerly taught. Mild cases generally yield promptly to proper treatment of the causative coryza. When deformity is evident and the pain great, a blister of cantharidal collodion should be placed over the frontal sinus, or just above it. Internally, atropine sulphate, $\frac{1}{480}$th of a grain every hour for sixteen hours, or until the throat is very dry, has a beneficial effect in many cases; the bromides in large doses also have a valuable controlling influence on the severity of the symptoms. Trephining the anterior wall is very rarely called for, and forcibly opening the sinus through the nose seems to me to be a wholly theoretical measure. Subacute or chronic cases usually soon get well if the nasal disease is cured. The mouth of the infundibulum, and probably a portion of its length, may be washed out and medicated by means of a delicate

[1] Hamilton, Journal of Laryngology, London, June, 1890.
[2] Medical Record, April 19, 1890.

curved syringe passed with great gentleness into the middle meatus. The introduction of a fine probe into the sinus, as recommended by Juratz, is feasible in a small proportion of cases only, and is of very doubt fulutility. Applications of pyoktanin are advocated by Cholewa, of Berlin, and have been largely used in Philadelphia. I regard it as one of the feeblest and most unpleasant of antiseptics, and much prefer solutions of carbolic acid, and oily solutions of the antiseptic volatile oils, camphor, menthol, etc.

DISEASES OF THE ETHMOIDAL SINUS.—These have been recently classified by Bosworth[1] as follows: (1) extra-cellular myxomatous degeneration, with or without purulent discharge; (2) purulent ethmoiditis with nasal polypi; (3) intra-cellular myxomatous degeneration, with or without pus.

The treatment advised by this author consists in uncovering the ethmoid cells by removing the convex cap of the middle turbinated body by means of the snare, and subsequently breaking up and destroying, as far as posssible, the trabeculæ by means of the electric burr or the curette. I should myself prefer to confine such radical, and not altogether safe, measures, to very severe and otherwise incurable cases. Most early cases will yield to the thorough use of antiseptic sprays, and of similar solutions thrown around the turbinated body by means of a delicate nasal syringe, with applications of iodine or europhen, and with general treatment of the naso-pharyngeal tract. Polypi and masses of granulation tissue must of course be removed by the snare or forceps to make room for future procedures, and the conservative use of a delicate curette is of value in a few cases. The region involved is particularly vulnerable, great subsequent irritation resulting from apparently mild procedures; and energetic treatment not infrequently originates the condition it is designed to cure.

Purulent ethmoiditis consists pathologically of an *osteitis granulosa* or a *caries suppurativa*,[2] and is essentially a deep-seated bone lesion. The ordinary symptoms are pain referred to the bridge of the nose or brow, interference with olfaction, and the usual symptoms of an aggravated chronic rhinitis. On inspection the middle meatus is found to be encroached upon by the enlarged middle turbinated body. The mucous membrane may be dry and rugose, or may be studded with polypi and oozing muco-pus. Probing is often better omitted; by its use the mass is usually found soft and yielding, and one or more areas of dead bone may be found; frequently, however, the areas are bared by the manipulation.

The treatment of all forms of chronic ethmoiditis consists in following generally accepted surgical principles: employing free drainage and antiseptic treatment, with stimulants to promote a more healthy action in the part. The various methods used by rhinologists to secure these results have been already indicated. Their special application depends on the conditions present in any given case.

PURULENT AND MYXOMATOUS DISEASE OF THE SPHENOIDAL SINUS.—This affection has had a number of cases added to its literature during

[1] New York Med. Journal, No. 675, 1891.
[2] MacDonald, Diseases of the Nose, 2d ed., p. 86.

the last few years. In a few cases only has the disease been recognized during life, and in still fewer has it been treated and cured. Ruault[1] has reported a case in which the sinus was trephined, drained, and cured, the procedures being carried out through the nasal passage. The great anatomical variability of this sinus, and the obscurity of the symptoms caused by its diseased conditions, render its therapeutics at present most uncertain.

Two cases of myxomatous polypus in the sphenoidal sinus have been reported, one by Zuckerkandl and the other by J. J. Clark;[2] in both the growths were found by post-mortem examination.

PURULENT INFLAMMATION OF THE MAXILLARY SINUS.—The diagnosis of antral disease has been greatly simplified by the introduction of the electric lamp into rhinological work. Trans-illumination is secured by introducing a five-volt lamp into the mouth and directing the patient to close the lips upon the handle; the room being darkened, the current is thrown on, and immediately a rosy-red light suffuses the face and gradually fades out as the eye is approached. If there be pus or a solid tumor in the antrum, that side of the face, especially opposite the molar prominence, is less bright than the opposite side. Cystic disease on the contrary gives more brilliant illumination of the affected side.[3] If from any cause the walls of the sinus are thickened, the illumination may be defective, and the diagnosis is therefore not positive but only confirmatory.

Purulent catarrh of the maxillary sinus, occurring as a sequel of acute or chronic rhinitis, very rarely calls for the radical measures lately in vogue. Many cases will get well without special treatment, if the nasal lesions can be cured, and even severe examples frequently recover without operative interference. All swellings which interfere with drainage from the antrum through its natural opening must first be removed—temporarily by cocaine, or permanently by applications of the galvano-cautery. The patient being instructed to lean the head toward the shoulder corresponding to the affected side, an atomizer throwing a strong coarse spray, or a nasal syringe, is introduced through the nasal speculum and pointed as nearly as may be at the opening of the sinus into the middle meatus. The spray or jet is then thrown into the nasal chamber with some force, and this is repeated one or more times at each sitting. Several weeks of daily or tri-weekly treatment may be required, but convalescence is usually less prolonged than after operative interference, and the patient is saved much pain and annoyance. Any non-irritating antiseptic solution may be used for the purpose, but peroxide of hydrogen has been less reliable in my hands than solutions of boric and carbolic acids, borate of sodium, and the volatile oils.

Intractable cases are only curable by drainage and irrigation, and the operation now almost universally favored is that of Mikulicz,[4] consisting in opening the sinus through the inferior meatus of the nose, either with a special knife or by means of a trocar. Dundas Grant advocates the use of a straight trocar and canula, three inches long by

[1] Arch. de Lar., de Rhin., etc., Juin, 1890.
[2] Journal of Laryngology and Rhinology, London, No. 2, 1892.
[3] Heryng, Berlin. klin. Woch., Nos. 35 und 36, 1889. [4] Archiv f. klin. Chir., 1887.

a millimetre and a half in diameter; the proximal end is made to fit the nozzle of a small syringe, after withdrawal of the trocar. The sinus is washed out with a warm antiseptic solution, and the puncture is kept open—with a short tube if necessary—and irrigated daily. Convalescence is frequently much retarded, and more stimulating solutions, possibly even silver nitrate, may be required. The whole nasal cavity should always receive appropriate treatment, and in direct relation to the thoroughness with which all minor details are carried out will be the success obtained in this as in all other diseases of this part.

INJURIES AND DISEASES OF THE FACE, CHEEKS, AND LIPS.

BY

JOHN B. ROBERTS, A.M., M.D.,

PROFESSOR OF SURGERY IN THE PHILADELPHIA POLYCLINIC AND IN THE WOMAN'S MEDICAL COLLEGE OF PENNSYLVANIA, SURGEON TO THE METHODIST HOSPITAL OF PHILADELPHIA.

IN this article will be considered the injuries and surgical diseases of the soft parts of the face, excluding those of the nose, mouth, eyes, and ears, which are considered elsewhere.

ANATOMICAL AND SURGICAL PECULIARITIES.

The skin of the face is thin, very vascular and elastic, and closely adherent to the subcutaneous cellular tissue and muscles. The direct insertion of many of the facial muscles into the lower surface of the skin not only prevents the latter from slipping freely over the underlying tissue, but gives to the face its lines or wrinkles of expression. Certain of these furrows, such as the naso-labial, are permanent even in repose; others are only made evident by ever-changing mental emotions. The muscular fibres are enveloped in deposits of adipose tissue, whose unusual absence in conditions of inanition gives the face under such circumstances a characteristic cadaveric appearance. The operating surgeon should remember not to make his incisions across these facial furrows of forehead or cheek, but parallel to or even along the bottom of them. Thus will he make the least conspicuous scars. Whenever possible a scar should be placed in a region usually in shadow. Thus it is that wounds made under the brow or lower margin of the jaw, and parallel to these bony edges, cause little deformity. Care should be taken that the hair of the eyebrow and beard should not be made to grow in an abnormal direction by unwisely placed incisions. It must be recollected that scars made in childhood increase in length as the patient grows; hence wounds made in badly chosen situations or directions may become undesirably conspicuous. An incision consisting of a series of long curves makes perhaps a less noticeable scar than a perfectly straight cut.

The free bleeding which is apt to obscure the seat of operation soon ceases under pressure with sponges or hæmostatic forceps, though torsion and an occasional catgut ligature may be demanded. Diminished

blood supply to the face may be temporarily obtained by digital compression of the common carotid arteries, or by acupressure of the trunks of the two facial arteries by means of acupressure pins or temporary ligatures, applied just before those vessels cross the lower margin of the jaw. It is stated that septic inflammations of the face spread with rapidity because the facial veins are unusually patent and free from valves, and communicate freely with the cavernous sinuses and internal jugular veins.

The bones of the face are very vascular, and hence readily unite after incision or fracture, and only become necrotic under severe septic processes. They yield somewhat to pressure, and seem to regain their original contour if not subjected to too great displacement. Congenital absence of the nasal and other bones of the face is occasionally seen and must be remembered as a possible cause of facial deformity.

Portions of tissue, osseous and soft, seemingly devitalized by injury, will often live and aid in the reconstruction of damaged areas; especially is this true if heat and an aseptic condition are maintained by frequent irrigation with warm water (105° F.). Pieces of the lip, ear, chin, or nose, completely severed by accident, will occasionally become adherent and live if promptly adjusted with fine sutures and kept warm and free from septic germs. Doubtful tissue should not be sacrificed until its destruction by gangrene has been fully determined.

These characteristics of the facial structures afford opportunity for much successful plastic and osteo-plastic surgery.

Incisions made obliquely to the plane of the surface can be approximated by fine sutures with greater accuracy than vertical cuts; and accidental wounds will at times leave less scarring if the contiguous edges are appropriately bevelled before the sutures are inserted. Fine catgut or silk makes the best suturing material; and a strip or two of gauze, held in position with collodion, the best dressing if the wound is aseptic. Catgut sometimes allows premature gaping of the edges because of its early absorption, and I am apt, therefore, to use fine sterile silk when I am especially anxious that the line of union shall be perfect. Drainage can be dispensed with in aseptic wounds. Attention to these details is essential in doing artistic work upon the face. Non-absorbable sutures should be removed in from two to five days.

When wounds of the cheek enter the mouth, it may be wise to approximate the mucous membrane by a special set of sutures introduced from the buccal surface. The cutaneous union can thus be kept more free from contamination by oral micro-organisms. In operation wounds of the cheeks and lips the mucous membrane should be left intact when possible. Drainage, when needed, should usually be made into the mouth, in order to prevent external scarring consequent upon delayed union. It has been proposed to unite wounds of the face by fine catgut sutures so inserted that the needle punctures are made on the cut edges of the true skin and not on the external surface, but this subcuticular method of suturing is unnecessary if oblique incisions and careful stitching are employed and if rapid union is thereby obtained.

Operative procedures on the face must be undertaken with a due respect for the duct of the parotid gland, which, lying under the deep fascia, runs as far forward as the anterior edge of the masseter muscle, in a line from the middle of the lobe of the ear to a point midway be-

tween the ala of the nose and the angle of the mouth. At the anterior edge of the masseter, which can readily be felt, it takes a deeper course and, perforating the buccinator and mucous membrane obliquely, enters the mouth opposite the second molar tooth of the upper jaw. If the nature of the operation requires division of this duct, it is good surgery to isolate the portion coming from the parotid gland, to make an opening through the buccal tissues into the mouth, and to carry the stump of the duct through this opening. Thus a new salivary orifice will be made in the mucous membrane and a cutaneous fistula will be avoided.

The branches of the seventh nerve, which give motion to the muscles of expression and radiate from a point just below the auricle, must not be ruthlessly divided by a longitudinal incision in front of the ear. The motor paralysis so induced would cause indescribable deformity. Division of the sensory nerves coming out of the supra-orbital, infra-orbital, and mental foramina is less objectionable, since the numbness thereby caused makes no change in the facial wrinkles or expression.

Skin grafting in its various forms, and plastic operations by all methods, have a most brilliant field in the prevention and correction of facial deformities. Occasionally it is well to allow a flap, raised for a reparative purpose, to thicken by inflammatory exudate before suturing it in place. Its tissue, drained of blood and with lowered temperature immediately after dissection, may gain additional vitality if not at once attached by stitches, and sloughing of its edges may thus be avoided. The insertion of a piece of aseptic oiled silk or rubber tissue under the flap will prevent its union to the underlying structures during the three or four days required for inflammatory plethora and thickening.

WOUNDS OF THE FACE.

The face especially escapes injury by reason of the mobility of the cervical vertebræ, the warning afforded by vision, and the automatic protection given by the upper extremities, the obliquity of the lower end of the humerus causing flexion of the elbow to bring the protecting hand directly in front of the mouth and lower part of the face.

The discoloration due to contusions is often a source of anxiety to the patient. Cold compresses with moderate pressure, continued for five or ten hours after the receipt of an injury, tend to lessen the subcutaneous bleeding and are advantageous, but subsequently cold applications should be omitted, as they probably delay the absorption upon which the removal of the discoloration depends. Multiple antiseptic punctures, followed by squeezing to extrude the extravasated blood, may be utilized in severe cases. Perfect asepsis must be maintained lest suppuration be induced. Chloride of ammonium, arnica, and other drugs applied locally, probably exert very little influence in hastening removal of the "black and blue" discoloration except when accompanied by friction, which is probably the valuable part of the treatment by these various lotions or liniments. The use of flesh-colored paint will partially disguise the alteration in color due to bruises.

Gunshot wounds of the face are best managed by applying at once

a dry antiseptic dressing without previously resorting to exploration with a probe, which will seldom give any valuable information and may cause sepsis. This primary antiseptic occlusion may lead to healing by means of a moist blood clot within the wound, since gunshot wounds in this region are often, and perhaps usually, aseptic.

Punctured wounds may be similarly managed unless there is reason to believe that the injury has been caused by a specially septic instrument. Then, of course, free incision and sterilization of the wound to its very bottom is demanded, but even under such circumstances it is often judicious to wait a few hours until preparations can be made for a thoroughly antiseptic operation.

Wounds involving the *nasal, tarsal, and auricular cartilages* may often be accurately approximated without passing the sutures through the cartilaginous tissue, though there is no objection to carrying the needle through the cartilage if preferred.

In wounds made by firearms at close range, particles of unburnt powder may become embedded in the skin, and if not removed will leave permanent blue stains similar to those produced by tattooing with carbonaceous substances. A similar discoloration is often found in miners and others who have been injured by blows from pieces of coal. The powder or coal-dust thus carried into the tissues should be removed immediately after the receipt of the injury. This may be accomplished by thoroughly scrubbing the burnt or lacerated parts with soap and water by means of a nail-brush. Anæsthesia may be required for the proper execution of this important part of the treatment. Picking out the particles of carbon with forceps is scarcely thorough enough. If healing has occurred over the embedded carbon, the blue disfigurement is only remediable by the tedious removal of every minute particle. Each blue point may be excised by a small circular punch, or croton oil may be pricked into the skin with a needle, and the pigment removed by the suppuration so induced. The minute white scars left by these methods are less noticeable than the tattoo marks. It has been proposed to attempt combustive destruction of the carbon by introducing a red-hot galvano-caustic needle into the skin at the discolored spots. The chemical applications employed by dermatologists to remove tattoo stains intentionally produced, may in certain cases be valuable; but discolorations due to accidental wounds are probably too deep to be satisfactorily removed by such means.

Cicatricial Deformities and Deformed Scars.

Cicatrices which would be of no importance on hidden parts of the body must be avoided on the face. Abscesses may sometimes be opened from the mouth, and an external scar avoided. The disfiguring and often self-convicting cicatrices of syphilitic ulcers and of gummy tumors allowed to ulcerate, are readily prevented by early and large doses of mercury and potassium iodide. No such lesion should be permitted to indelibly mar the features because of the carelessness or ignorance of a surgeon who looks for syphilis only in the lowly.

Tuberculous abscesses should be incised and curetted before the skin becomes thinned and a puckered scar probable. Spontaneous evacua-

tion is therefore to be deprecated. Occasionally a softened tubercular gland, or a tubercular abscess, may be drained by transfixing it with a needle carrying wire, silkworm gut, or silk, and leaving the suture material in the abscess as a sort of seton. This method is valuable as a means of preventing increase in the abscess and thinning of the skin when incision and curetting have to be delayed, but the latter operation is always preferable. The depressed scar of an old tubercular abscess may be improved by abrading the surface of the scar, making an elliptical incision around it, and drawing the skin over the abraded surface. This elevates the surface and substitutes a linear cicatrix for the depressed and often puckered one. By another method, suggested by Mr. W. Adams, the depressed tissues are separated from the underlying fascia by a tenotome introduced subcutaneously. Then the scar tissue is elevated to the level of the surrounding skin, and is held in that position by small pins passed underneath. After a few days the pins are withdrawn, leaving the skin fixed in its new situation.

When moles, warts, and other tumors, or malignant ulcers, are to be removed, the incisions should be so planned as to minimize the deformity from cicatricial contraction. In many instances a plastic procedure should be done as a part of the preliminary operation, in order to lessen the cicatrizing tension or transfer it to an area where it will do little harm. These plastic operations justify by their ultimate results the additional incisions and consequently augmented hemorrhage.

Fig. 1707.

Bardenheuer's Method for Prevention of Cicatricial Closure of Jaw.

Excisions of growths near the eyelids and mouth very frequently require the gap left to be thus closed by cutaneous flaps from the neighboring skin. It is usually desirable to do both parts of the operation at one sitting, but quite frequently, as in all plastic surgery, secondary or tertiary operations are needed to get the most perfect result.

When the entire thickness of the cheeks at the corners of the mouth is extensively removed, as for malignant disease, cicatricial lockjaw is pretty certain to occur if the tissues are drawn together by sutures. Unless a plastic reconstruction of the cheek (*meloplasty*) is at once done by means of a flap from the neck or elsewhere, it is better to allow the wound to heal by granulation, since under these circumstances, the patient's use of his jaws may lessen, though it will not entirely obviate, the cicatricial trismus. Bardenheuer[1] fills the gap by a flap cut from the forehead. This he turns downward, so that the skin of the brow substitutes the mucous membrane of the mouth. The raw surface of the flap occupying the gap in the cheek is then covered by a flap taken from the neck, so that the two flaps are placed with their raw surfaces in apposition. (Fig. 1707.)

This method of preventing cicatricial anchylosis is said to be better

[1] Deutsche medicinische Wochenschrift. Sajous's Annual of the Universal Medical Sciences, vol. iii., 1892.

than treating it after occurrence by osteotomy of the lower jaw so as to make a false joint. Another method of reconstructing the cheek is to dissect a flap from the neck, make a button-hole incision under the lower jaw into the mouth, carry the flap through this opening, and suture it in the gap left by the excised tumor, with the skin surface toward the oral cavity. If the surgeon prefer, the flap may have Thiersch skin shavings applied to its raw surface, either before or after its utilization to close the opening. Sometimes a mucous surface can be given to the region where scar contraction will be most marked, by dissecting a large flap of mucous membrane from each of the lips in front of the excised area, displacing these flaps backward over the gap, and suturing together their upper and lower edges respectively.

Plastic operations on the face by V-shaped incision, by sliding, twisting, or overturning of flaps, by osteoplastic methods, or by grafting bone, muscle, or skin, are conducted on the general principles of plastic surgery. The pedicles of such flaps as those used in the method of meloplasty just described, are divided after their circulation has been secured from the new region. The surfaces left bare by the dissection of the flaps should be immediately covered with a pavement of skin shavings.

When very large portions of the face have been lost by injury, operation, or disease, prosthetic appliances of celluloid, wax, and other materials may be successfully constructed to imitate the missing structures. The artistic success of these attempts is sometimes unexpectedly good.

The keloid growth that occurs in old scars not unfrequently returns after excision. It is said that in negroes, in whom keloid disease is common, the excrescence softens and even disappears as the patient advances in adult life.[1]

Fistulæ upon the Surface of the Face.

Fistulous openings upon the face occur in connection with injuries and diseases of the salivary and lachrymal apparatus, the frontal and maxillary sinuses, and the mouth. Sloughing of the tissues of the cheeks, from excessive ptyalism or from gangrene as a sequel of one of the fevers of low type, may readily cause a communication between the surface of the cheek and the cavity of the mouth.

These same pathological changes, or wounds of the cheek, may cause a salivary fistula, whereby the secretion of the parotid gland is emptied upon the cutaneous surface because of an abnormal opening into the parotid duct. Similar lesions may result in salivary fistulæ of the ducts of the sublingual and submaxillary glands, the location of the abnormal orifice varying with the anatomical situation of the primary lesion.

Abscesses or gangrene may give rise to a communication between a lobule of one of the salivary glands and the surface, thus causing a fistula in which the duct of the gland is not involved. The saliva escaping from the abnormal orifices in such glandular fistulæ will probably be less in amount than from openings of the same size connecting

[1] See Dr. J. Collins Warren's paper, and subsequent discussion, on Cicatrices, etc., in Transactions of the American Surgical Association, vol. xi., 1893.

with the ducts. It is possible for the saliva to escape from an ulcerating or otherwise diseased lobule, and, burrowing under the tissues, to make its exit, or cause a cystic tumor, at a distant point. Garretson records a case in which he believed that the sublingual gland had thus communicated with and caused distention of a bursa above the hyoid bone. Agnew saw a congenital salivary fistula which opened on the auricle at the anterior part of the helix. A blow may cause subcutaneous rupture of the parotid duct and cause swelling from salivary infiltration. Impaction of fishbones, air, or calculi in the salivary ducts may cause obstruction and inflammatory symptoms leading to fistulæ. I once treated a case of inflammatory obstruction of the parotid duct in which there occurred a transudation upon the cheek when the patient's salivary glands were stimulated by masticating food. This was probably saliva leaking through the skin. The patient unfortunately passed out of my care before a chemical examination of the exuded fluid had been made.

Necrosis of the malar bone may cause sinuses whose orifices resemble salivary fistulæ. Garretson records a case of sinus in the face, due to a misplaced molar tooth lying on the ramus of the lower jaw under the parotid gland. It, of course, did not discharge saliva. The probe and chemical tests will aid in the diagnosis of such cases. Tincture of chloride of iron, mixed on a white surface with the suspected fluid, will give a pink reaction with the sulphocyanide of potassium present if saliva is mixed with the discharge.

In operating on the deep structures of the cheek, the exact position of the duct of the parotid gland may be kept in view by passing a fine lachrymal probe or acupuncture needle along its track from the buccal opening. Ordinarily, however, the line already given will be a sufficient guide to its position.

Various operations have been employed for closing the external orifice in salivary fistula. The essential part of the treatment is the establishment of a free opening for leading the saliva into the mouth. After this has been accomplished, the cutaneous orifice will often close spontaneously. The exact location of the oral orifice made by the surgeon is not important, if it remains sufficiently large.

The late Dr. Post, in his article on this subject in Vol. IV. of the Encyclopædia, has detailed several methods. One or two others may with propriety be mentioned here. An opening for salivary drainage, at or above the fistula, may be made into the mouth, as advised by Agnew, by passing a probe along the duct from the mucous surface of the cheek, and then carrying a thread, by means of a needle, around the probe through the tissues without perforating the skin. The probe is then withdrawn, and the ligature, which has been introduced from the mouth, is tied and allowed to ulcerate through the encircled duct and mucous membrane. Thus the duct is cut off from the external opening, which is closed by the application of stimulants or caustics, or by a plastic procedure, if spontaneous healing does not occur. In some cases a cure may be effected by slitting up the duct with scissors and suturing the mucous membrane so as to divert the stream of saliva from the external orifice. Garretson has succeeded in making the internal opening large and the cutaneous orifice small by using a conical plug, of cotton or wire, carried through the entire thickness of

the cheek. A mere thread comes through the cutaneous opening while the base of the cone occupies the opening in the mucous membrane. Thus the saliva is carried in the direction of the larger opening, and finally the minute external opening is closed.

Irregularly placed glandular fistulæ may be remediable only by dissecting out the offending portion of the secreting gland.

Fistulæ resulting from suppurative disease of the frontal sinus and lachrymal sac usually need the establishment of drainage downward into the nose. Antral accumulations may be drained into the nose by a perforation made below the inferior turbinated bone, or into the mouth by an opening made above the bicuspid teeth. A drill or strong cartilage knife should be employed, and the opening should be kept patulous by a tent or plug. The cavity often requires irrigation with mild antiseptic solutions if the cure is to be expedited. Extraction of a tooth is seldom required.

Facial Spasm.

The intractable spasm of the muscles supplied by the facial nerve, called *histrionic spasm* or *tic convulsif*, at times becomes so annoying that the surgeon is consulted. The spasms which are usually clonic, though occasionally tonic, are not associated with pain, and this disease is quite different from the neuralgia of the fifth cranial nerve called tic douloureux. Gray has proposed the term *palmus* for the former condition.[1]

The patient should not be subjected to stretching of the facial nerve, which has some value at least as a temporary measure, until medical treatment has proved to be unavailing. Galvanism has been employed, as have arsenic, atropine, and kindred remedies, administered by hypodermic injection or by the mouth. Hammond claims to have given some relief by an apparatus consisting of a spring and pads, to make pressure on the facial nerves at their points of exit. This was worn by his patient with benefit, but the pressure could not be borne for more than a couple of hours.

Nerve stretching has not been very satisfactory; but it is an operation of no special danger, and has afforded relief for as much as five years in at least one case. The incision, made immediately behind the auricle, should be about two and a half inches long, and angular, with the apex of the angle, in the middle of the cut, pointing backward at the point of the mastoid process. The facial nerve is found in the narrow space between the parotid gland in front and the sterno-cleido-mastoid muscle behind. The nerve is situated at a depth of from one to one and a half inches, and lies in front of the fascia over the prevertebral muscles. It is uncovered at about a half-inch in front of the stylo-mastoid foramen, through which the nerve makes its exit from the cranium, and is in front of the centre of the anterior margin of the mastoid process, and from a quarter to a half inch anterior to that spot. If the posterior belly of the digastric is seen, the operator must keep above its border. The transverse processes of the vertebræ and the styloid process are aids to the identification of the relations.

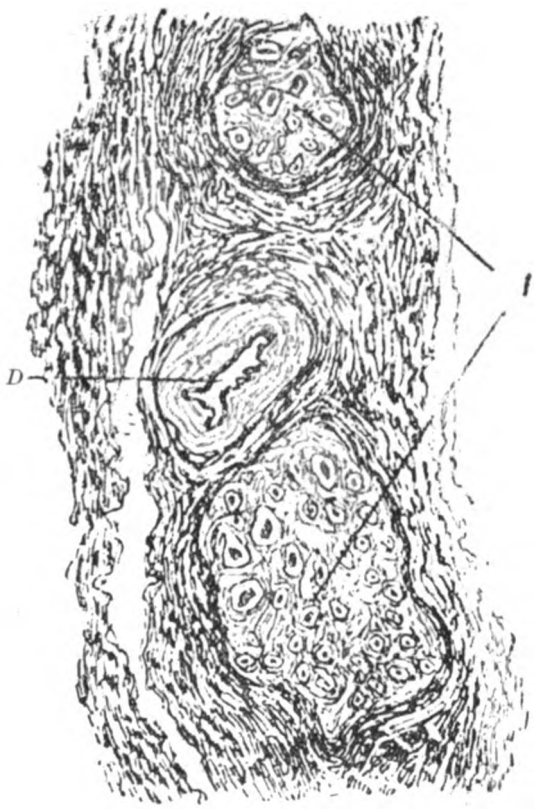
Reflected light from a head-mirror may be requisite to illuminate the

[1] Amer. Journ. Med. Sci., May, 1895, p. 535.

deep cavity. A needle-like electrode passed successively over the various structures in the bottom of the wound, while a wet sponge electrode is applied to the cheek, will identify the nerve by causing twitching of the facial muscles. The current should be weak, since a strong current will, according to Keen,[1] produce muscular reaction even when the electrode is not in contact with the nerve, because the moisture in the wound will conduct the current to all the exposed tissues. Baum's method of reaching the nerve, which is here described, is preferable to that by an incision in front of the auricle, as advocated by Hueter.

Neurectomy will stop the spasm, but causes a disfiguring palsy. Facial neurotomy with immediate nerve-suture occurs to me as a possible method of treatment. The section would relieve the spasm, and muscular power would probably return as regeneration of the sutured nerve took place.

Fig. 1708.



Nerve Changes in Trigeminal Neuralgia. (Rose.)

TRIGEMINAL NEURALGIA.

The neuralgia which affects the fifth cranial nerve often demands surgical treatment. The disease is sometimes called "facial" neuralgia, but this is a confusing designation, since it may lead to the supposition that it affects the seventh cranial, or facial, nerve, which is a motor nerve and the seat of the spasmodic motor affection just described as tic convulsif. *Tic douloureux*, *trifacial neuralgia*, and *epileptiform neuralgia of the fifth nerve* are better descriptive names for the malady now under consideration. The name epileptiform neuralgia is applicable because of the irregularly occurring explosions or convulsions of agonizing pain in the areas of distribution of one or more of the three divisions of the nerve. The motor nerves of the face, however, may be secondarily affected, causing muscular contortion or local paralysis; but these symptoms are incidental and not necessarily present.

The superior and inferior maxillary divisions are more apt to be the seat of this violent neuralgia than the supra-orbital division, which is the frequent location of the simple neuralgias associated with malaria and migraine.

[1] Trans. American Surgical Association, 1886, p. 285.

The pathology and causation of this torturing disease is not understood. It has been asserted that obliterating endarteritis of the nutrient vessels of the nerve is often present,[1] and evidences of sclerosis of the nerves and ascending neuritis have been found. (Fig. 1708.) The suggestion that syphilis may be an agency in the etiology seems plausible if endarteritis is the factor of importance. The conditions giving rise to the pain, whatever they are, may be situated in the deep origin of the nerve fibres in the pons and medulla, in the sensory root before it reaches the Gasserian ganglion, in the ganglion, or in the nerve trunks or branches. It is possible that the nerves may be subjected to pressure at their foramina of exit from the skull, because of a relatively small orifice, or of swelling due to periostitis or perineuritis. Peripheral causes may be cicatrices, tumors, diseased teeth, foreign bodies, retained secretion in the frontal sinus, and similar irritating lesions. The operative treatment will be modified by the character of the supposed etiology. Every organ should be examined, and every ascertainable cause of toxic, reflex, or functional irritation should be removed.

The disease is one of middle or advanced age, and is characterized by attacks of more or less periodic shooting pain, exceedingly severe, and radiating from the supra-orbital, infra-orbital, or mental foramen. During the intervals between these paroxysms there may be no pain at all, or irregular painful sensations which are quite insignificant as compared with the epileptiform neuralgic paroxysms. The disease usually attacks one side of the face only, and may be located in one, two, or all three divisions of the trifacial nerve. Gradually, in the course of months or years, the paroxysms become more frequent and the intervals shorter. The patient finally becomes dominated with the dread of causing an outbreak of pain, which is started by talking, eating, coughing, or having anything touch the skin over the distribution of the peripheral branches of the nerve. Unexpected noises or draughts of air may incite a seizure. Facial contortions, at the time the lancinating pain occurs, as well as ptosis, strabismus, and clonic spasm of the muscles moving the lower jaw or head, may occur from secondary implication of motor nerves. Hyperæmia or tumefaction of the face, lachrymation, sweating, and other vascular and secretory symptoms may occur on the affected side of the face and mouth.

Medicinal treatment is of service in the milder cases, and in the early stages of those which finally require operative measures. Many remedies such as quinine, chloral, cocaine, arsenic, aconite, antipyrine, gelsemium, and nitroglycerin have been used with varying success, as have local applications of menthol, croton-chloral, and belladonna. Nitroglycerin, sodium nitrite, and similar drugs seem specially indicated in view of the investigations of Dana and Putnam pointing to obliterative endarteritis as a possible cause of the disease.

Great relief to the patient is afforded by excision of the nerves affected, but the pain usually returns in a few months or years. The comfort experienced after neurectomy is, however, so immediate and so great that the operation should be performed as soon as the inefficiency of medicinal treatment is established. Thus the pain-habit and the grave disturbances of health, due to years of agonizing neuralgia, may be de-

[1] C. L. Dana, Journal of Nervous and Mental Disease, No. 1, 1891.

layed. Sometimes, though very rarely, the patient is permanently cured. The recurrence of pain is due to regeneration of the excised nerve tissue, or to a sort of nervous anastomosis taking place through communicating nerves. Hence, neurotomy is not to be recommended, but neurectomy, combined with stretching of the central and peripheral portions of the affected nerve, should be chosen. As large a piece of nerve as can be readily reached should be excised. The operation should be repeated as often as the pain returns, for experience shows that removal of the unidentified structures at the seat of a former operation, and the stretching of the supposed nerve-stump, will afford further relief, often lasting many months.

The operative attack should be made upon the nerve as near its central origin as possible, due regard, however, being had for the risks of those operations which aim at excision of the Gasserian ganglion itself, or of the deep portions of any of the three divisions. Neurectomy of the branches making exit at the supra-orbital, infra-orbital, or mental foramina respectively, is practically free from danger, and often gives great comfort. These points should therefore be chosen for the earlier operations. It will be readily understood that these operations will be ineffective if the lesion is behind the foramina, but it is rare that the surgeon can localize the cause of the neuralgia. The painful nerve, after exposure, should be thoroughly stretched by traction in both a central and a peripheral direction, and an inch or more, if possible, of the nerve trunk should be extracted.

In operating upon the second division of the nerve, the spheno-palatine ganglion (Meckel's) just in front of the foramen rotundum should be removed, if neurectomy at the infra-orbital foramen, with extraction of a long piece of nerve, has proved unavailing. If the third division is the painful trunk, excision should be done above the dental foramen in the lower jaw, or just below the oval foramen in the sphenoid bone, if neurectomy at the mental foramen or in the inferior dental canal has failed to give relief. As the exact seat and nature of the cause of the disease is usually undeterminable, success is more apt to be obtained, and a longer period of freedom from pain gained, by cutting away the nerve as near the brain as possible. The torturing character of the disease makes death preferable to life, wherefore the most severe operative procedures are ultimately justifiable. The less severe operations, however, should be undertaken before those which are more dangerous are recommended to the patient. If two or all three of the divisions of the trigeminus are affected, the deeper operations are more clearly indicated. Ligation of the common carotid artery [1] of the affected side has given relief in some cases. I have twice performed this operation in patients previously subjected to neurectomy of the anterior parts of the nerves. Both cases were immediately relieved, but in time the pain recurred, and in one of them I subsequently did an intracranial neurectomy of the second and third divisions immediately in front of the Gasserian ganglion.

Neurectomy of the supra-orbital nerve or terminal branch of the first division is performed by a horizontal incision just below the eyebrow, over the junction of the inner and middle thirds of the supra-orbital

[1] An elaborate article on the various operations and their results, by Dr. G. R. Fowler, will be found in the Annals of Surgery, vol. iii., for 1886.

ridge. The attachment of the eyelid to the bone is divided and the orbital fat pressed downward, and the nerve is then isolated, lifted up on a strabismus or other blunt hook, and divided as far back in the orbit as possible. Before its division it should be grasped by forceps far back and drawn forward, so as to stretch the portion near the brain. After it has been divided, traction should be made on the part to be excised, in order that the peripheral branches supplying the forehead may be stretched and dragged out of the tissues. This method enables the surgeon to extract the greatest amount of the nerve and its branches.

The second division is dealt with by the orbital, antral, or ptergygo-maxillary route. The various methods are well described in detail by Rose.[1] One method of operating by each route will here suffice. The *infra-orbital* foramen is exposed by a transverse cut under the orbit. A second incision may be made from the nasal end of the first incision along the naso-labial furrow. This additional wound gives more room by enabling the surgeon to turn down a flap, but is not essential. A longitudinal cut from the middle of the first incision is, I think, less desirable, because of the greater prominence of the cicatrix. The portion of the lower margin of the orbit above the foramen is readily cut out by a chisel, and access is thus obtained to the nerve. The orbital contents are next carefully held up with a retractor, while the thin roof of the canal in the floor of the orbit is broken through and the nerve uncovered. It is stretched with forceps and cut off as far back in the orbit as possible. The peripheral branches are then torn out of the muscles and skin, by steady traction made on the detached piece of nerve. If the operator prefer, the periosteum may be detached from the floor of the orbit and held up along with the eye and orbital fat, while the canal is being laid open.

When the *antral* route is chosen, illumination with an electric light and mirror is almost a necessity. A Y-shaped or T-shaped incision, with the centre over the foramen and the lower end extending nearly to the corner of the mouth, lays bare the front of the upper jawbone. The anterior wall of the antrum is then opened by a chisel or trephine, the posterior wall of the cavity similarly perforated, and the spheno-maxillary fossa reached. Incision of the mucous membrane of the roof of the antrum, and breaking away the layer of bone under the nerve, give the surgeon an opportunity to remove the latter with or without the spheno-palatine ganglion, which, however, should be removed if possible. Bleeding is often very free during the deep manipulations, but pressure with gauze is readily applied and is usually sufficient. There is no objection to cutting off and ligating the arteries which accompany the painful nerves in their canals, when operating upon any of the divisions.

The *pterygo-maxillary* operation may be done by an inverted V-shaped incision, with the apex just behind and below the external angular process of the frontal bone. One limb of the Λ is carried downward and backward to the tragus, and the other downward and forward upon the cheek, the zygoma is sawn through near each extremity, the temporal fascia is detached from the upper edge of the zygoma, and the detached zygoma with the masseter is turned downward. The

[1] The Surgical Treatment of Neuralgia of the Fifth Nerve, by Wm. Rose, F.R.C.S. London, 1892.

fissure between the pterygoid process and the upper jawbone is thus uncovered, and the spheno-palatine ganglion of Meckel is made accessible. To remove the infra-orbital nerve as well as the ganglion, an additional operation under the orbital margin is required. Rose considers this method a good one, if it is decided not to attempt extirpation of the Gasserian ganglion itself. (Fig. 1709.)

Fig. 1709.

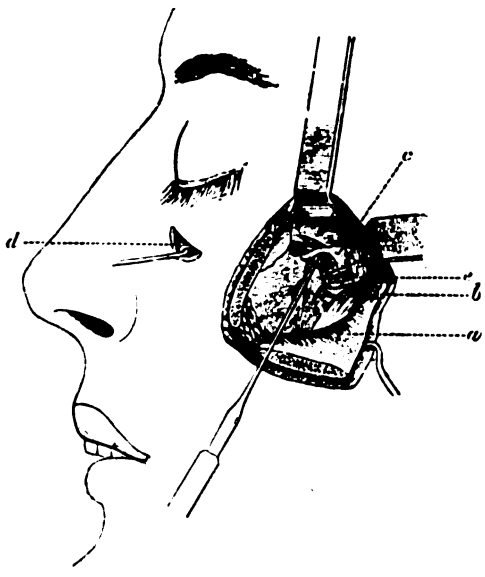
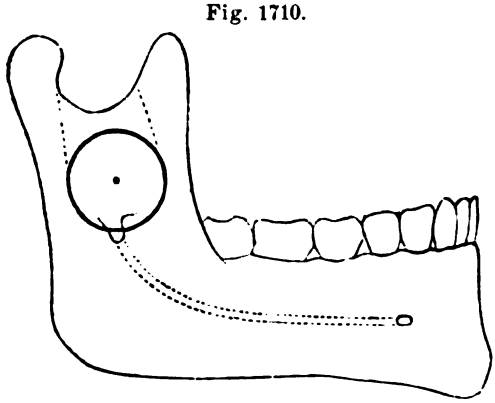


Diagram Showing Dissection Necessary to Expose Second Division of Fifth Nerve, According to Braun-Lossen Method. *a*, Zygomatic arch divided and turned down; *b*, temporal tendon arising from coronoid process and held back by retractor; *c*, superior maxillary nerve and Meckel's ganglion; *d*, infra-orbital nerve at emergence from canal. (Rose.)

The lingual and inferior dental nerves are the sensory branches of the third division which usually demand surgical treatment for neuralgia. The latter is the only one claiming attention in an article on the surgery of the face, as the lingual nerve comes within the limits of the surgery of the oral cavity. The inferior dental nerve may be excised at the mental foramen by an incision made through the mucous membrane within the mouth, or through the skin. In the cutaneous method the incision should be made under the lower border of the jaw, the skin being then drawn upward. It is better, however, to reach the nerve within the canal by cutting away the anterior layer of the jaw with trephine or chisel, near the junction of the body and the ascending ramus. Several inches of the nerve can be removed by subsequently chiselling out the roof of the canal as far forward as the mental foramen. It can be satisfactorily excised also just above its entrance into the inferior dental canal, by trephining the jaw below the sigmoid notch and deepening that notch by cutting away the bridge over the opening thus made. (Fig. 1710.)

Fig. 1710.



Side View of Lower Jaw Showing Position of Trephine Opening in Operation for Deepening Sigmoid Notch. The Two Upper Dotted Lines Indicate the Extent of the Bridge of Bone. (Rose.)

This is a good method of reaching the lingual nerve as well as the inferior dental, and is practically the same operation as that used by Rose to reach and divide the third division just under the oval foramen. A large horseshoe incision is made around

the posterior border of the ascending ramus of the lower jaw. It begins about the middle of the zygoma, is carried downward and backward, and then forward below the lower border of the horizontal ramus. After the flap is raised, the deep fascia and masseter muscle are cut by a transverse incision below and parallel to the parotid duct. The periosteum is then raised, the bone trephined, and the sigmoid notch deepened by cutting away the bridge of bone above the trephine perforation. The nerve can then be excised just as it emerges from the foramen ovale or a little distance below it, according to the wishes of the operator.

When the operations already described for trigeminal neuralgia have failed to give permanent relief, it is proper to enter the cranium and excise the nerve trunks in front of the Gasserian ganglion, and to remove as much as possible of the ganglion itself. This may be done by trephining the base of the skull, or by opening it through the squamous portion of the temporal bone. The former operation has been especially advocated and employed by Rose[1] and Andrews,[2] while the latter has been perfected by Hartley and Krause, though previously suggested by Horsley.

The basal method requires section of the zygoma and coronoid process, detachment of the masseter and temporal muscles, and the application of a specially constructed trephine or chisel to the region near the oval foramen. After the ganglion has been extirpated the divided bones are sutured, or the zygoma may be sutured and the coronoid process removed.

This operation seems to be more formidable than that by opening the skull through the temporal fossa according to Hartley's method.[3] Experience on the cadaver and in the living subject has convinced me of the value and feasibility of the latter operation. An omega-shaped incision is made over the temporal fossa, so that the ends of the cut will be near the tragus and external angular process of the frontal bone, and its convexity at the temporal ridge. The tissues are incised down to the bone, and a chisel or surgical engine is then used to divide the bone along the same line. With an elevator the divided bone and soft tissues are pried up, and are turned down over the zygoma as a sort of trap-door. The bone breaks across the base of the incision, and the skin, muscle, and periosteum serve as a hinge. The middle meningeal artery is seen in the dura and ligated if necessary, and the dura is then carefully detached from the base of the skull until the three divisions of the trigeminus and the Gasserian ganglion are exposed. Care is required to avoid injuring the cavernous sinus, and illumination by an electric-light head-mirror is almost a requisite. After the ganglion has been curetted away with a small sharp spoon, or torn out with forceps, the brain and dura are allowed to fall into their normal position, the osteoplastic flap is turned up so as to close the opening in the cranium, and sutures are applied. (See Figs. 1694, 1695, pp. 636, 637, *supra*.)

Many surgeons have operated by this route and method with rapid union of the wound and satisfactory results. The cases are too recent, however, to prove anything as to permanency of cure. The ganglion has not been removed in all the cases, but in certain of them an intra-

[1] Op. cit. [2] Journal of American Medical Association, 1891.
[3] Annals of Surgery, May, 1893, p. 512.

cranial neurectomy only has been done. Mr. Rose has operated by the basal method on at least six cases, with one death, and Andrews and others have taken this route. Horsley's[1] method of reaching the ganglion and the emerging nerve-trunks by opening the dura mater and exposing the temporo-sphenoidal lobe is a more serious operation than Hartley's modification. One of Rose's patients had been free from pain for nearly two years after removal of the ganglion, and was still well when the report was made.

A recent survey of the literature of the subject shows 21 cases operated upon by the basal route, with 3 deaths, and 20 cases operated upon by the temporal route, with 2 deaths.[2]

Fig. 1711.

Aggravated Harelip; Fissure Extending Into Eye and Cranium. (Wyeth.)

HARELIP.

This deformity is due to imperfect closure of the embryonic fissures of the fœtus. The congenital defect may be so extensive as to include the cheek and head as well as the lip. Very rarely a similar cleft is found in the lower lip; and occasionally the cleft in the upper lip is in the median line. The recent monograph of Rose gives much valuable information about the causation and varieties of this malformation.

The correction of the deformity in harelip involves much more than the mere closure of the cleft. The lip, even in simple cases, is usually imperfectly developed on the side of the cleft away from the middle line. This is fully appreciable when the lips are closed, and should be noticed in every case before the incisions are made. The operator must lengthen this side of the lip and elevate the nasal ala, flattening of which ordinarily accompanies the labial defect. There must be a perfect adaptation of the skin and mucous membrane at the junction of these structures on the edge of the lip, and no vermilion mucous membrane should be permitted to remain along the cutaneous scar left by the operation. Error is sometimes committed by not freeing the lip thoroughly from the upper jaw. The first step should consist in dividing the mucous membrane between the lip and gum, and paring the tissues loose on both sides of the median line. This detachment may at times go as high as the infra-orbital foramen before the tension has been sufficiently relieved.

Fig. 1712.

Congenital Fissure of Lower Lip and Jaw: Tongue in Fissure. Thorndike's Case. (Bryant.)

[1] British Medical Journal, Dec. 5, 1891.

[2] See the author's article in Dennis's "System of Surgery," vol. ii., p. 914.

An estimate of the character of the incisions to be made is obtained by observing the manner in which the upper lip is deficient in length on one side. I have often satisfactorily lengthened the lip and narrowed the flattened nostril by an incision along the groove between the wing of the nose and the cheek, with a transverse incision outward from the cut made in denuding the edge of the congenital gap. This makes a curved flap to be displaced downward, lengthening the lip, and frees the ala of the nose so that it can be brought nearer the septum either with or without sutures. The incisions which pare off the edges of the cleft should change their direction before they reach the border of the lip, and turn inward so as to leave a tongue of tissue covered by mucous membrane; these tongues assist in lengthening the lip, and also prevent the notch in its margin which is often seen when the wound has healed. (Fig. 1714.)

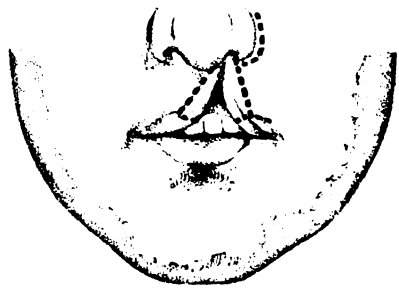
Fig. 1713.

Central Fissure of Lip With Deficiency of Intermaxillary Bones. Howse's Case. (Bryant.)

It is important that the denudation of the edges should include enough tissue to reach a place where the edges attain the full thickness of the lip. Inexperienced operators sometimes cut away too little, and have only thin edges to bring together with the sutures.

Instead of sacrificing tissue by paring away the edges of the cleft in order to get freshened surfaces of contact, the operator may split the margins of the gap where mucous membrane and skin come together, parallel to the plane of the lip. This is similar to the flap-splitting operation employed in repairing old lacerations of the perineum. The mucous are more voluminous than the cutaneous flaps, and may, as suggested by Fenger,[1] be first brought together across the gap by sutures tied within the mouth. The muscles and skin are subsequently united by other sutures tied on the outside, and the outer wound is thus shut off from the micro-organisms of the mouth. In this operation the harelip-pin suture is abandoned, and silk, silkworm gut, or wire is used. I myself have abandoned the pin suture in harelip operations, whatever form of incision is adopted. An aseptic wound, with silk sutures and a collodion dressing, gives great satisfaction. If pins are used they should be removed in two or three days, as their longer retention is liable to cause undesirable scarring.

Fig. 1714.



Method of Lengthening Short Side of Cleft in Harelip and Decreasing Flattening of Nose by Incisions. One Extending Outwards Along Muco-cutaneous Junction and One Around Ala of Nose.

[1] Journal American Medical Association, August 1, 1891, p. 176.

INJURIES AND DISEASES OF THE MOUTH, TONGUE, FAUCES, PALATE, AND JAWS.

BY

J. EWING MEARS, M.D.,

PROFESSOR OF ANATOMY AND CLINICAL SURGERY IN THE PENNSYLVANIA COLLEGE OF DENTAL SURGERY, GYNÆCOLOGIST TO THE JEFFERSON MEDICAL COLLEGE HOSPITAL, SURGEON TO ST. AGNES'S HOSPITAL, EX-PRESIDENT OF THE AMERICAN SURGICAL ASSOCIATION, ETC.

AFFECTIONS OF THE TONGUE.

WOUNDS OF THE TONGUE.—In operations for the relief of wounds of the tongue, it is desirable that the surgeon should have the organ under complete control. This is best accomplished by passing a strong aseptic silk ligature through its apex and tying it in a loop. Anæsthesia should be induced in all cases of a serious nature, especially in children. Hemorrhage from wounds of the tongue is sometimes very difficult to control, and in patients who are the subjects of hæmophilia death may follow from slight wounds, as by biting the tongue. In cases of severe hemorrhage, or when the ranine artery is wounded, it may be necessary to apply a ligature to the lingual artery as it passes forward above the border of the greater cornu of the hyoid bone.

Owing to the moisture of the tongue and its constant movement, sutures when applied should be very carefully tied.

In gunshot wounds of the tongue the ball may lodge in its substance, and instances are recorded in which a bullet, passing through the jaw, has driven a tooth into the tongue, the tooth becoming embedded and producing severe inflammation. The foreign body may be detected by passing a probe along the track of the wound, and when its position is ascertained it should be excised.

CONDITIONS AFFECTING THE FRÆNUM.—The frænum of the tongue may be so short as to interfere with the proper movements in suction on the part of the child. The test as to the absence of this condition is the ability of the child to project the tip sufficiently forward to touch the red border of the lower lip. Very severe hemorrhage has occurred from division of the frænum owing to wounding of the ranine artery. Absence of the frænum has been noted in a number of instances. In these cases, the tongue falls back into the fauces and presents the appearance of a tumor. Danger from suffocation is constantly present, and one case is reported in which death occurred from this cause.

Suturing the tongue to the floor of the mouth was suggested by the late Professor S. D. Gross as a means of relief, although doubtful as to its efficacy.

RANULA.—In addition to the methods of treatment usually practised, I have found incision of the cyst-wall, evacuation of the contents, and packing with iodoform gauze successful.

CYSTS.—Later investigations into the character of sublingual cysts show that they are usually dermoid and may contain hair, teeth, and bone, as well as the usual cheesy matter found in dermoid cysts. They are formed by involution of the epiblast during development, and are situated between the muscles connected with the tongue and the floor of the mouth. This fact makes their removal through the mouth sometimes difficult, especially if they have attained any considerable size.

CARCINOMA OF THE TONGUE.—Carcinomatous affections of the tongue and their treatment by surgical procedures have been so thoroughly discussed by Mr. Heath in the fourth volume of this work that but little can be added. In a paper read before the American Surgical Association, Dr. N. P. Dandridge[1] concludes that the removal of the tongue in carcinomatous affections is justifiable, prolongs life, adds comfort to the patient, and affords a reasonable hope of permanent cure. All operations should be preceded by an effort to secure thorough disinfection of the mouth and teeth. When the disease is confined to the tongue, Whitehead's method, removal by the scissors, is preferred. Preliminary ligature of the lingual artery is not considered necessary. Unilateral extirpation is advocated when disease is limited to one-half of the organ, and Baker's method of tearing through the raphe should always be employed. When the disease has extended to and involved the floor of the mouth, submaxillary gland and cervical glands, Kocher's operation is advised. By this operation the cavity of the mouth is opened through the digastric triangle, and the tongue, being drawn through the wound, is removed by the scissors or galvano-cautery. Preliminary tracheotomy is performed with subsequent tamponade of the fauces. The glands involved can be removed by the incisions made to enter the mouth. Preliminary tracheotomy is thought to add an unnecessary element of danger to removal of the tongue, in ordinary cases. Volkmann has achieved remarkable successes in cases of extensive disease by opening the mouth by lateral division of the lower jaw at the position of the canine or first molar tooth. It is desirable in all cases to get the patient out of bed at the earliest possible moment after the operation, and to feed him generously. Allusion has been made by by Mr. Heath to ligation of the lingual artery for the purpose of checking hemorrhage and arresting the growth of cancerous disease of the tongue. In the case of a man aged sixty-five years who suffered from carcinoma involving the left side of the tongue, palate, floor of the mouth, and inner surface of the cheek, I tied the left common carotid artery, with the result of securing cicatrization of the ulcerated surfaces; right hemiplegia, however, followed the operation, and within a year the patient died from exhaustion.

[1] Transactions, vol. x., 1892.

Malformations and Diseases of the Palate.

Cleft Palate.—Within the past few years the discussion of the question as to the operative or mechanical treatment of cleft of the palate has been revived, and great activity has been manifested in devising new methods of operative procedure through which better results as to articulation have been secured. The great difficulty of obtaining the adaptation of a perfectly satisfactory mechanical appliance, and the necessity which exists of its occasional renewal and its constant cleansing, make it desirable to avoid these conditions by operation, even if perfect articulation is not attained by such procedure. Diligent investigation, study of results obtained, and repeated efforts by new methods, will, it would seem probable, lead to the removal of difficulties which now prevent perfect results. With the view of giving such movement to the soft palate as will enable it after operation to be placed against the posterior wall of the pharynx, and thus efficiently shut off the nasal from the pharyngeal cavity, Billroth has devised an operation by means of which the mucous membrane at the side of the velum is alone divided and then used to cover the cleft, after the internal plates of the pterygoid processes are severed by the chisel and approximated. This procedure completely relaxes the tensor palati muscles, and permits the palate to be acted upon by the levator palati and palato-pharyngei in such manner as to bring it in contact with the posterior pharyngeal wall. Billroth ascribes the failure to secure the application of the soft palate to the posterior wall of the pharynx, to the division of a circular muscle, the anterior portion of which is contained in the velum. If, in the operation of closure, the remaining part of this muscle be cut through, occlusion of the nasal cavities becomes impossible; hence the incision of only the mucous membrane and section of the internal pterygoid plates. Wolff[1] claims great advantages for a plastic operation over the use of mechanical appliances. He also discusses the post-operative treatment for the correction of speech troubles.

The opinion of surgeons has been modified of late with regard to the time for removal of the sutures. Formerly it was thought desirable to permit them to remain from a period of from six days to a fortnight, and Mr. Heath states that fine wire sutures may be left for weeks or even months, as long as they do not scratch the tongue. My experience has been unfavorable to this practice, fistulous tracks occurring in some instances in the line of the suture as a result of this long retention. I now endeavor to secure removal of all sutures within a period of five or six days, removing one or two on the third or fourth and the remaining on the fifth or sixth day.

Rotter, of Munich, describes[2] an operation for cleft palate in a case in which there was also a labial fissure. To close the cleft he borrowed a frontal periosteal skin flap with a long pedicle, grafting the raw surface of the flap with epidermal grafts, and holding it with its grafted surface up upon the forehead, with a bandage, for a period of eight days. At the expiration of this time the grafts had taken, giving a skin flap cov-

[1] Berliner klinische Wochenschrift, 4 März, 1890.
[2] Münchener medicinische Wochenschrift.

ered with epidermis on both sides. The object of this was to prevent the drying up of the flap when in position and exposed to the double air current, nasal and oral. This method, which was successful in the case reported, can only be employed where a labial cleft coexists with a cleft of the palate.

Affections of the Pharynx.

Wounds of the Pharynx.—These are usually self-inflicted. They may, however, be the result of accident, or may be produced in surgical operations. When suicidal, homicidal, or accidental, their gravity may be greatly increased by the involvement of adjacent structures. In simple wounds of the part hemorrhage is usually slight and readily controlled. Emphysema of the neck may follow a wound of the pharynx, as may also aphonia from the contiguity of the larynx. A question of interest relates to the use of sutures in closing the pharyngeal wound: formerly it was the practice to close the wound of the pharynx and that through the overlying tissues separately, but experience has shown that the introduction of sutures in the pharyngeal wound is apt to lead to inflammation and sloughing, and that the reparative process follows more quickly in such wounds when not closed by stitches. The wound in the superficial tissues may be sutured, space being left for drainage by tube or gauze. For a few days liquids and foods may pass through the wound, but this may be partially overcome by attention to the position of the patient's head, which should be inclined to the side opposite the wound. If it be found necessary, alimentation may be conducted by the rectum and afterward the stomach-tube may be employed. Fistulæ sometimes follow pharyngeal wounds and become sources of great annoyance and discomfort. The use of the galvanocautery, or of nitrate of silver applied by means of the porte-caustique, may be of service in causing their obliteration.

Tonsillitis.—Two forms of acute inflammation of the tonsils are recognized—the follicular and the parenchymatous. The former involves the lining membrane of the follicles, which branch out into the substance of the gland and the adenoid capsules which surround them. In the parenchymatous variety the entire gland is involved. The rheumatic and gouty diathesis has been assigned as a cause of tonsillitis, as has sexual excitement. The high temperature, with the great prostration which attends the severe forms of inflammation of the tonsils, has led to the opinion that the disease is of septic origin. The late Professor Agnew attributed great importance to the use of guaiacum as a remedy in the parenchymatous form. Three or four grains may be given every two or three hours in the form of a lozenge, which is allowed to dissolve in the mouth, its action being supplemented by the local application of the ammoniated tincture of guaiac to the surface of the tonsils.

Pharyngitis.—A form of pharyngitis characterized by a dry, red, and glazed condition of the mucous membrane sometimes exists in persons of advanced life who have suffered from repeated attacks of

catarrh. As in these cases the submucous connective tissue gradually disappears, the disease has been designated atrophic pharyngitis. Internal administration as well as topical application of cubebs or of ammonium muriate may palliate the affection. In order to keep the mouth closed during sleep and thus prevent dryness of the fauces, it is advised to hold the jaws together at night with a bandage.

TUMORS OF THE PHARYNX.—While tumors of the pharynx are rare in their occurrence, instances are recorded in which the various forms of lipoma, papilloma, fibroma, and chondroma have been observed. The most usual varieties are the adenoma, sarcoma, and carcinoma. Adenoma appears most frequently in the shape of vegetations covering the roof and sides of the pharynx, which give rise to constant hawking, and sometimes to difficulty of hearing and of articulation. Inspection of the pharynx will reveal the growths when they extend below the palatal arch, and by the aid of the pharyngeal mirror they may be seen when seated above this point. In mild cases they may be removed by the application of a dilute solution of nitrate of silver. When firm they may require the use of scissors, Volkmann's spoon, or the galvanic cautery. Carcinoma of the pharynx is usually associated with disease of adjacent structures. When a large surface is involved but little can be accomplished for relief by operative procedures. When the disease is limited to the lateral or posterior portion of the pharynx, sub-hyoidean pharyngotomy may be successfully performed. In one case Billroth removed the pharynx, part of the œsophagus, and the entire larynx except the epiglottis, part of the trachea, and the thyroid gland. The patient died at the end of six weeks from the accidental passage of a sound into the mediastinum. Sarcoma of the round-celled variety invades the pharynx, and may be removed by operation through the mouth, or in graver cases by sub-hyoidean pharyngotomy.

RETROPHARYNGEAL TUMORS.—I have reported the successful removal of a sarcomatous tumor of the size of a lemon from the basilar portion of the occipital bone by the method of operation described by Cheever, through the neck, with division of the lower jaw and incision of the pharynx; slight necrosis of the jaw followed.

AFFECTIONS OF THE JAWS.

ALVEOLAR ABSCESS is defined to be an abscess at the apex of the root of a tooth, due to inflammation originating in the tissues of an exposed pulp and conveyed to the apex by continuity of structure. The tissues lining the walls of the alveolus and reflected on the root of the tooth, may become involved. The treatment in the early stage should be conducted by the dentist, and consists in the treatment of the diseased tooth by cleaning out the affected tissues of the pulp cavity and of the root canal, and by the use of antiseptic douches and packing with proper materials saturated with antiseptic agents.

Treatment of this character often results in stopping the inflammatory action and saving the tooth, which, although dead, may be made useful by proper filling. When the tooth is very much diseased and its

body to a great extent destroyed, it may become necessary to remove it and treat the inflammatory condition in the alveolus by antiseptic methods. In some cases, when the condition of the roots permits, an artificial tooth may be attached by pins and bands.

NECROSIS OF THE JAWS.—Of the various forms of necrosis of the jaws, that produced by the specific effect of phosphorus is of special interest. The disease exists to a great degree among the operatives in match factories in certain portions of the United States, notwithstanding the successful results achieved abroad in its prevention. In a paper read before the American Surgical Association in 1885[1] I announced as my belief, founded on observations made in a number of cases under my care, that the necrotic action was not caused, as had been stated, by the fumes of phosphorus attacking the periosteum through diseased teeth, or through the cavities after extraction of teeth, but that the periosteum of those who had long been exposed to the fumes of the poison was so altered as to make it very susceptible to irritation, and that the irritation accompanying a diseased tooth, or that associated with the efforts at extraction of diseased teeth, was the factor in the production of inflammation in the already diseased membrane.

CLOSURE OF THE JAWS.—Permanent closure of the jaws may be due to unilateral or bilateral cicatricial formations in the buccal spaces, or to anchylosis of the temporo-maxillary articulation on one or both sides. For the former condition, I have devised a method of operation which in a number of cases of bilateral involvement has afforded complete relief, and has permitted permanent opening of the mouth to the extent of an inch and three-quarters between the teeth. Having failed by the methods in use, I was led to adopt one which consists in the passage of a double aseptic silk ligature, by means of a handled, slightly curved needle, between the integument of the cheek and the surface of the cicatricial mass, entering the point of the needle at the corner of the mouth and bringing it out at a point opposite the last molar tooth. The ligature being deposited, is loosely tied and allowed to remain *in situ* from two to three weeks, or until the surgeon is satisfied that a mucous lining membrane has formed in the canal in which it lies. In order to form this canal the ligature should be drawn backward and forward in its track from time to time. When the lining membrane is formed the cicatricial mass may be divided with the knife, or may be gradually cut through by the ligature, which should then be tied firmly. Subsequent to the division of the mass, the mouth is opened to its fullest extent daily by the use of a mouth gag. In a few weeks this may be dispensed with, and the unaided efforts of the patient in opening the mouth may be depended upon to secure permanent relief. It is very desirable in passing the needle that it should be carried closely in contact with the inner surface of the skin, so as not to pass through any portion of the cicatricial mass. In the case of a patient who had suffered from closure of the jaws for a period of twenty-seven years, and who had been the subject of an unsuccessful operation by other methods, I succeeded in affording complete relief by this plan, the mouth being opened to the extent of one and a half

[1] Transactions, vol. iii.

inches; and as the improvement has now continued for six years, it may be regarded as permanent.

In anchylosis of the temporo-maxillary articulation I have also obtained good results, in a number of cases, by section of the ramus of the jaw and removal of both coronoid and condyloid processes, thus affording ample room for the formation of a false joint. The operation is performed through the mouth by passing a tenotome beneath the masseter muscle, making an opening through which an Adams saw is carried and the bone is divided. An effort is then made by seizing the upper fragment with the lion-jawed forceps, to twist it out of place. If this movement does not succeed, a chisel is placed in the wound over the neck of the condyle, and this portion is cut through, sufficient bone being gouged out of the glenoid fossa to give space. The anterior portion of the upper fragment, with the coronoid process, may be removed with cutting pliers, the attachment of the temporal muscle being severed by a blunt-pointed knife. In every instance in which this method has been employed a permanent and fully movable false joint has been established, permitting opening of the mouth to the normal extent, and without any lateral deviation of the lower jaw.

INJURIES AND DISEASES OF THE NECK.

BY

JOSEPH RANSOHOFF, M.D., F.R.C.S. ENG.,

PROFESSOR OF ANATOMY AND CLINICAL SURGERY IN THE MEDICAL COLLEGE OF OHIO, SURGEON TO THE CINCINNATI HOSPITAL AND TO THE GOOD SAMARITAN HOSPITAL, CINCINNATI.

ABSCESS OF THE NECK.

THE loose connective-tissue planes of the neck and the lymphatic glands embedded within them are often the seat of purulent infection. This may develop primarily in the neck as a consequence of penetrating wounds, from without or from within, as from the pharynx or œsophagus, or may result from direct extension of a like affection from the floor of the mouth, tonsils, jaw, parotid gland, or vertebral column. In the great majority of instances, however, a cervical abscess begins as an adenitis, the result of septic inoculation of a lymphatic gland from a primary lesion situated somewhere in the vast territory drained by the cervical lymph-nodes and plexuses. Although they most often follow infectious lesions of the naso-pharynx and its appendages, abscesses may ensue from apparently trivial lesions of the face, the nasal passages, the external ear, or the scalp. The source of the infection may not be easy to determine, the primary lesion, often slight, having disappeared before manifestations of glandular infiltration are discoverable.

Among the gravest abscesses of the neck are those which follow in the wake of typhoid fever, small-pox, diphtheria, and particularly scarlatina. To account for these is not difficult when we consider the frequency with which fissuring about the tongue, and erosions and ulcerations of the pharynx, occur in these diseases. Therefore in addition to the usual pyogenic organisms, the pus from cervical abscesses has been found to contain the bacillus of typhoid, the diplococcus of pneumonia, the ordinary spirillum, and the micrococcus tetrogenes.[1]

Abscess of the neck for the most part begins as an adenitis of one or a number of glands of a group nearest the point of primary infection. The inflammatory process may, as in glands elsewhere, stop short of suppurative softening, for it is quite certain that besides its function as a filter for septogenic organisms the lymphatic gland can through its wealth of cells render many of them inert. When overwhelmed, pus is produced. From within the glandular capsule, converted into a pus-sac, the peri-glandular connective tissue is invaded with greater or less

[1] Roswell Park, Med. News, Oct. 16, 1888.

rapidity, adhesion to the overlying structures follows, and nature forms the path for the spontaneous or operative cure of the condition.

While abscesses of the neck may be diffuse, there is a distinct tendency toward limitation by fasciæ and connective-tissue planes within certain well-defined spaces. This applies to purulent foci above and below the deep fasciæ. The sub-maxillary gland, with intra-glandular and extra-glandular lymphatics, is contained in such a pocket, from which abscesses are not prone to extend. Indeed, its walls are so imperforate that any marked infiltration of this region will make itself manifest through pressure effects on the tongue, pharynx, larynx, and vessels situated underneath it. General septic infiltration and sloughing follow this enchained inflammation, which is fatal in over forty per cent. of the cases in which it occurs. Having been accurately described by Ludwig,[1] this deep-seated phlegmon of the neck is known as "Angina Ludovici" by continental writers. As early as 1822 Gregory gave a graphic description of the disease.[2] In England the subject has been ably treated by R. W. Parker[3] and Morrant Baker.[4] It is the termination in sloughing with its attendant grave septic manifestations that distinguishes this "sub-maxillary phlegmon" or "deep phlegmon of the neck" from milder processes in the same region.

Abscesses in this region are oftenest encountered in children, are relatively of slow development, and, owing to this and to the greater resistance of tissues generally in the young, are not often phlegmonous in character. The more acute the process the greater is the danger of sloughing.

A second pocket within which purulent foci are found is underneath the layer of deep fascia which joins the proximal margins of the sternal muscles and lies in front of the trachea. Contained within it are the loosest connective tissue of the neck, ocasionally a median lymph-node, and the thyroid. The abscesses here encountered are ordinarily the result of wounds or operations on the air passages.

Tracheotomy is sometimes followed by a peri-tracheal cellulitis which by extension to the mediastinum becomes fatal. Unopened abscesses in this area sometimes cause tracheal stenosis. Koenig[5] reports the case of a child on whom he was about to perform tracheotomy. In front of the trachea and extending into the mediastinum an abscess as large as a walnut was encountered. When this was evacuated, respiration became so free that the opening of the trachea was not found necessary.

A third space is that which corresponds to the superior carotid triangle. The large number of lymphatic glands which surround the vascular sheath and are beneath both borders of the sterno-mastoid muscle, makes this, next to the sub-maxillary triangle, the favorite site of cervical abscesses. Often of slow growth when they follow suppurative, tubercular, or syphilitic adenitis, or when secondary to malignant disease of the subjacent gullet, they are not infrequently mistaken for neoplasms, or for arterial lesions on account of the pulsation of the underlying carotid. When pointing occurs, it may be in front of or be-

[1] Schmidt's Jahrbücher, 1837. Bd. xv., S. 25.
[2] London Med. and Phys. Journal, 1822.
[3] Lancet, 1879, vol. ii.
[4] St. Barth. Hosp. Reports, 1890.
[5] Lehrbuch f. spec. Chirurgie, Bd. i.

hind the sterno-mastoid, but in either event the downward progress of the abscess will usually be limited by the fascial covering of the omo-hyoid. In other cases, unless operative measures are instituted, the abscess will dissect its way along the great blood-vessels to the root of the neck and through the upper chest aperture.

Not a few lymphatic glands are found in the supra-clavicular triangle, in which abscesses may develop without connection with other pockets of the neck. A cervical abscess, in a patient recently in the wards of the Good Samaritan Hospital, developed in the wake of a suppurating cavity in the apex of the left lung. Abscesses from the axilla often extend into this region, and *vice versa*. Secondary abscesses dependent on cervical caries sometimes progress in this direction, following the sheaths of the brachial nerves. The dorsal portion of the neck is not often the seat of true abscess, on account of the scarcity of its lymphatics and the greater resistance of its integument. Abscess here may, however, follow furunculosis, or a slight infected wound.

In addition to the usual dangers incident to suppuration, deep abscesses of the neck are sometimes followed by serious and even fatal hemorrhage. This remark applies particularly to the post-scarlatinal suppuration in which lesions of the veins predominate, although venous hemorrhage is comparatively infrequent. The lesser resistance of the walls of the vein permits the obliteration of its calibre. The thicker arterial wall on the other hand will ulcerate before occlusion can take place.[1] The first extensive tabulation of cases in which the primitive carotid, internal carotid and subclavian, or their larger branches, were opened, was prepared by S. W. Gross.[2]

The hemorrhage may follow the opening of the abscess immediately, or it may not occur for a number of days. When smaller arteries are opened the hemorrhage will probably be recurrent, although the ulceration of even primitive trunks may not prove fatal except after repeated bleedings.

ACTINOMYCOSIS.

Closely resembling in their clinical features chronic cervical abscesses are the suppurating granulomata of actinomycosis, first described in man by Israel.[3] The ray fungus may gain access through carious teeth, ulcerated gums, or tonsils, and may find a nidus in the cervical glands. The point of invasion in the mouth or pharynx may not show any trace of the disease. Cases of this kind have recently been reported by Ranneft and Blok.[4] Although the fungus may itself produce pus, the suppuration in actinomycosis is generally caused by the ordinary pus-forming organisms. The discharge from actinomycotic abscesses may be whey-like in appearance, or may resemble the pus of chronic abscesses from other causes. Its characteristic is the presence in the pus of many yellow or pearly granules, at most the size of a pin's head, which when examined by transmitted light are distinctly brownish. Microscopic examination reveals more or less complete rosettes of club-shaped fungi. In cases of what might be termed primary cervical

[1] Lindner, Deutsch. med. Wochenschr., 1887, S. 522.
[2] Amer. Journ. Med. Sciences, 1871.
[3] Virchow's Archiv, Bd. lxxiv., S. 15. [4] Annals of Surgery, vol. xii., p. 392.

actinomycosis, the diagnosis sometimes cannot be made from abscesses due to other causes except by an incision. When the actinomycotic tumor is single, without nodules, and fluctuating, absolute differentiation from abscess may be impossible. Since, however, incision, curetting and drainage are indicated in the one as in the other, and in both will be followed by a permanent cure, the question of diagnosis may be considered of minor importance.

Tuberculosis of the Neck.

Chronic inflammations of the lymph nodes of the neck, in Sir George Macleod's article [1] denominated "scrofulous," are now known to be tuberculous in character. Marked by indolence, multiplicity, and a tendency to develop during childhood and adolescence, they are the result of an infection from the mouth, pharynx, or tonsil, and continue long after the primary lesion has disappeared. Ordinarily the gland nearest the seat of invasion is first infected, and within its capsule the diseased process is limited. Sooner or later the glands in the vicinity are involved, until in well-marked cases a single or double chain of lymphatic tumors extends from the angle of the jaw to the clavicle. While only a few of the glands are involved, the danger from general tuberculosis is not marked, the glandular capsule efficiently protecting the system. Weigert [2] demonstrates that the virus in some cases is successively deposited in contiguous lymphatic glands until it reaches the venous circulation through a lymph-duct, but that in the greater number generalization takes place more directly through a vein. The bacillus tuberculosis is not motile, and therefore infection is carried in the course of the lymph current, or by amœboid cells through the blood.

It is a matter of ordinary clinical observation that only a small percentage of strumous glands terminate in miliary tuberculosis. Nor is pulmonary tuberculosis a frequent congener or sequel of a like affection of the cervical glands. In 148 cases analyzed by Frankel [3] the lungs were affected in only 15. While the anæmia and malnutrition of tuberculosis were marked in 18 patients, the general health was not impaired in 72. Tubercular adenitis is principally a localized infection process. In patients under five years it is often associated with or followed by tuberculosis of other parts, when the local condition in the neck forms but an unimportant factor of the generalized condition. According to Tibert, Schell, and Lucke, the largest number of tuberculous cases are encountered between the ages of ten and twenty.

In its beginning, a tubercular gland appears to the naked eye in the guise of a simple hyperplasia. The tumor is firm, consistent, elastic, and on section presents a uniform, grayish, translucent surface. Recent investigations of Friedlander, Koster, Koenig, and others, have shown that in the early stage of the disease miliary nodules are already present, and that within them, far removed from the blood-supply, are the giant-cells of Langhans. It remained for Koch to demonstrate that within the latter were contained the bacilli. In very young subjects

[1] See Vol. V., *supra*.
[2] Verbreitungswege der Tuberculose. Jahrbuch f. Kinderheilk., Bd. xxi., S. 146.
[3] Prag. Zeitschrift f. Heilk., 1885, S. 283.

caseation in and about the nodules speedily ensues. Foci, central and peripheral, become fused until the entire gland capsule is filled with a thick cheesy material resembling inspissated pus, but which primarily contains none of the pus formers. Not infrequently secondary infection by the latter occurs. Often the formation of an abscess leads the way to an abiding cure of a tubercular adenitis.

When suppuration attacks a number of glands, extensive peri-adenitis generally results, and in consequence numerous fistulæ leading to the glands are formed. Often the latter are found embedded in the abscess cavity, the glandular inflammation being overshadowed by the more extensive process in the surrounding tissues.

In older subjects the process of caseation is of slow development, and may not occur at all. It is not uncommon to find tubercular glands as large as a hulled walnut or an egg, which though present for years show no trace of softening. Between these extremes of the rapidly caseating and the hyperplastic tubercular adenitis, all grades are found, not only in different individuals but in one and the same. Some trivial, local, histological cause may induce caseation in more than half of an entire chain of lymphatics, while the remaining glands in the immediate vicinity are not similarly affected.

As in tuberculosis of all forms, the hygienic and medicinal treatment of that of the cervical lymphatic glands merits much consideration. The preparations of iodine, iron, and cod-liver oil, have long been found useful, not through any specific effect, but because they are good tonics. In two cases, quite recently under my care, I observed an almost total disappearance of the double row of glands, some of which had been softened, under the protracted use of creasote. While the tuberculin of Koch promised much for glandular as well as other forms of tuberculosis, it has been very largely discarded, though there are those who still use it in its modified forms, and in minimal doses, with claims of good results and of freedom from the dangers incident to its original mode of employment. When caseation has taken place within a gland capsule, an occasional success may follow iodoform injection. The old-fashioned collar or stock, to keep the parts at rest, may sometimes be used with advantage.

There is a large number of cases in which, despite local and systemic therapy, the condition remains unchanged, or progresses in regard to the number of glands involved and the tendency to early caseation. Certain is it that in these the operation of complete excision rests on sound surgical principle. While but few of the glands are involved and the peri-glandular structures are free, the operation is simple in the extreme, and with proper precautions is devoid of danger, Lindenbaum [1] reporting 94 operations without a death. The two sides of the neck may be operated on at separate sittings, and practically all the deep-seated lymphatics may be removed. The remaining cicatrices, though they may extend from ear to sternum, are linear, and far less disfiguring than those resulting from spontaneous cure after prolonged suppuration. Nor can the operation be said to be especially difficult when the entire chain of the deep-seated lymphatics is involved, unless extensive sinuses or widespread infiltration of peri-glandular tissues exists. To shell out one gland after another until it is believed that all are removed, use-

[1] Centralbl. f. Chir., 1891, S. 357.

lessly prolongs the operation and enhances its difficulties. By an incision extending from above the uppermost to a point below the lowermost gland, the entire anterior surface of the chain should be freely exposed before any attempt to remove a gland is made. With a small four-pronged hook the uppermost gland is then drawn into the wound, the air penetrates the loose connective tissue behind it, and with a little traction on the hook, and here and there the division of a few fibres with the scissors, it is lifted from its bed. If possible, the connection of the gland with that below it should not be divided. Traction on this interglandular tissue exposes the next gland, which in turn is seized with the sharp hook and drawn forward, and thus the way is prepared for seizure of the next gland underneath. In this manner, by an incision made from mastoid process to clavicle, I have within three years, in eleven operations, removed the entire chain of deep-seated lymphatics from one or both sides in a surprisingly short time without either death or serious complication. The hemorrhage while the glands are movable is not profuse, and is easily controlled by pressure forceps or by ligature. In one of my cases the internal jugular vein was wounded. In 128 cases reported from Billroth's clinic by Frankel the jugular had to be tied in 16.

A danger not to be overlooked in the operation on the parotid lymphatics, is the division of the facial nerve. This followed an operation by one of my assistants at the Cincinnati Hospital. The patient was a mulatto child of six, from whom I had removed the entire chain from the right side of the neck at a previous operation. The paralysis while complete was of comparatively short duration. Frankel observed facial paresis after 18 operations, but in only 6 was it permanent. In 104 cases operated on in Lucke's clinic paralysis ensued in four. In two of these it soon disappeared, but in two it continued three years subsequently.[1]

The difficulties and the perils of the operation are increased, not so much with the number of glands involved, as with the extent of the periglandular infiltration. When suppuration has taken place in and about many of the glands, the operation may become, from adhesion to important veins and nerve trunks, quite formidable. Indeed, at times it may be wiser to leave part of a suppurating gland than to incur the risks of complete extirpation. After thorough curetting it may be safely left to granulate under an iodoform gauze tampon, while the remainder of the wound is closed by sutures in the usual way. In my judgment no part of a caseating tubercular gland ought ever to be buried in a closed wound. To do so would expose the patient to all the dangers of auto-infection of contiguous tissues which were incident to the older methods of removing the caseous foci with a curette, leaving apparently healthy gland tissue and capsule as infallible sources of re-infection.

When cervical adeno-tuberculosis is associated with tuberculosis elsewhere, an operation is contra-indicated, as it is also in the acute forms of the disease in which high temperature and rapid extension downward indicate a malignant type. Nor should an operation be counselled in the very young. Fortunately, according to the observations of Schnell,[2] Haehl,[3] Kish, Lebert, and others, the majority of cases are

[1] Haehl, Zeitschr. f. Chir., Bd. xxxv., S. 392.
[2] Erfolge von Extirpation tuberculöser Lymphoma. Bonn, 1885. [3] Loc. cit.

encountered between the ages of six and twenty, and at a time of life when even extensive operations are safely borne. The measure of success following the operation is determined by the time at which it is done. Even without selection of specially favorable cases, extirpation is followed by most gratifying immediate and final results. When suppuration has been absent before the operation, the wound is permanently healed in from two to three weeks. Local return after a period of three or more years occurs in less than ten per cent. of these cases, and reappearance of the disease elsewhere in only four per cent. In from fifty-seven to seventy per cent. of all cases the operation is followed by complete and permanent recovery.

LEUKÆMIA AND PSEUDO-LEUKÆMIA.

Closely allied in their early manifestations to tuberculosis are the true lymphomata of glandular leukæmia and of malignant multiple lymphoma, commonly known as Hodgkin's disease, or malignant lymphosarcoma. Both affections develop with predilection in the cervical glands, both superficial and deep, and with greater or less rapidity involve the lymph glands of the axilla and groin, and the deep-seated glands of the trunk. Both diseases occur chiefly in the young, but may occur in adults or even in the old. (Fig. 1715.)

Fig. 1715.

Malignant Lymphoma of Two Years' Duration in a Man of Seventy.

There is profound disturbance of nutrition in both forms of lymphoma. Common to both are the pale waxy skin, blanched mucous membranes, systolic heart murmur, great weakness, dropsy, and tendency to hemorrhage. The differentiating feature is the great increase in the number of white blood corpuscles in the simple, and the absence of such increase in the malignant type of the disease. A microscopic count of the blood corpuscles infallibly determines the nature of the lymphoma. The malignancy of Hodgkin's disease is further made manifest by secondary deposits, chiefly in the lungs, spleen, liver, and kidneys. The leukæmic variety is rarely associated with like changes in the spleen.

According to Winiwarter and Hutchinson, Hodgkin's disease may develop rather suddenly in an individual who has had indolent glandular tumors localized in the neck or axilla for a long time, possibly for years. Quite often the accession of

disease in new chains of glands is attended by febrile exacerbations. Clinically, therefore, there is reason for the belief that the disease is of microbic origin, and that the infection of the glands proceeds through the blood-vessels. Glands far removed from each other are often simultaneously enlarged, while those belonging to a chain of which one is already infected may remain normal. Usually the enlargement attacks groups of glands in relation with the larger arterial trunks. The glandular tumor always presents a uniform surface. It may be soft, almost to the point of fluctuation, or firm and elastic, like cartilage. The attempt to divide malignant lymphadenoma into a firm and soft variety has been made, but without reason, since it is not unusual for both forms of tumor to be present in one chain of glands. Though a false fluctuation may be present, the tumor never disintegrates, nor does it through peri-adenitis form adhesions to the integument. Whether hard or soft it is always freely movable underneath its coverings, and it forms no attachment to glands in its vicinity. The glands can be moved on and about each other with perfect freedom. Attention to these characteristics marks this disease from tuberculosis, with which it most readily may be confounded.

The course of this disease is toward a fatal issue in periods varying from one to five years. In the case of a young girl, recently observed, death resulted in a little less than eight months from the appearance of the first glandular swelling in the neck. According to Hutchinson and others, the disease may remain latent in one or two glands for a number of years, and then without any known cause become quickly generalized. When the diagnosis can be made early, extirpation may prevent extension of the disease. In advanced cases surgical interference can only be harmful, unless it be made to relieve urgent pressure-symptoms on the part of the trachea or œsophagus.

Lympho-Sarcoma of the Neck.

Distinct from the disease just considered is the sarcoma which develops and remains localized in one of the glands of the neck, usually a deep-seated one in connection with the surface or within the sheath of the large vessels. It presents the pathological changes and clinical tendencies of sarcomas elsewhere. Round or spindle-celled in character, the tumor is first distinctly encapsulated within the gland. In its growth it involves muscles, nerves, skin, and blood-vessels, and not infrequently perforates the larger veins. Early metastases are therefore sometimes observed in lungs, liver, or spleen.

As the tumor approaches the surface, the superficial veins are dilated. The skin assumes a bluish tint and glistening appearance. With the formation of adhesions its nutrition is impaired. It becomes thinner and thinner and finally ulcerates. With the repressing influence of the skin lost, the tumor grows rapidly beyond the general level of the integument, and often assumes a cauliflower form. Whether protruding or not, the exposed surface yields a sanguinolent discharge, always offensive and often largely formed of blood. With or without traumatism, hemorrhages both profuse and recurrent greatly reduce the patient. Purulent infection often is added to the condition and aids not a little in expediting the fatal termination.

From their attachment to the vascular sheaths these tumors often receive an imparted pulsation. Almost invariably the attachment is to the jugular rather than to the carotid, probably on account of the greater resistance offered by the firmer coats of the latter to the advancing neoplasm. In its growth the tumor disturbs the anatomical relations of vein and artery, so that it sometimes happens, as in a case operated on by myself, that an inch or more of the vein is excised with the tumor while the artery is not seen in the wound. A further reason for this more frequent involvement of the vein must be sought in the fact that many of these tumors, as Langenbeck first pointed out, develop from or in the vascular sheath, either from the minute lymph nodes or from the firm connective tissue found within. Since all lymphatic tissues are in relation rather to the venous than to the arterial trunks, these growths primarily attach themselves to the former.

Rarer than the lympho-sarcoma are the fascial sarcomata springing from the deep-seated fascia of the neck. They appear principally about the root of the neck in the supraclavicular fossæ or in front of the trachea. They are of firmer consistence, contain less of the round-celled elements than the lympho-sarcoma, and develop no tendency toward metastasis. In point of recurrence *in loco* they are very malignant.

But most malignant of the sarcomata of the neck is the melanotic variety, which at times develops primarily in the skin or lymphatic glands of the part. Virchow reports a case of this kind, and Diettrich [1] several years ago collected ten cases in only one of which did the patient die of an intercurrent disease. The operations were followed by recurrence in from two weeks to four months. When death followed the operation, secondary deposits were as a rule encountered in the viscera of the trunk. It is therefore doubtful whether, when the diagnosis can be made, operative interference is justified. When, however, melano-sarcoma has developed in a gland it may be impossible to recognize it prior to operation.[2]

Carcinoma of the Neck.

Primary malignant neoplasms of epithelial origin are rare in the neck. They are often encountered in the cervical glands, secondary to primary disease in the tongue, lip, fauces, œsophagus, or mamma. It may be claimed that primary carcinoma never develops in lymphatic glands. As elsewhere, epithelioma may develop primarily in the integument from a wart, a syphilitic or tubercular ulcer, or the scar of a burn. At times primary malignant disease of the pharynx or thyroid gland will involve the neck in its growth toward the integument.

In 1882 Volkmann [3] first described three cases of deep-seated primary cervical carcinoma which he believed sprang from retained epithelial vestiges of the branchial clefts, quiescent through many years, until stimulated by some unknown cause to the hetero-plastic cell proliferation of carcinoma. König [4] has seen a number of such cases. Others have been described by Samter,[5] Richard,[6] and Gussenbauer.[7] They

[1] Archiv f. klin. Chirurg., Bd. xxxv., S. 292.
[2] Settegast, Ibid., Bd. xxiv., S. 692.
[3] Centralbl. f. Chir., 1882, S. 49.
[4] Lehrbuch d. spec. Chir., Bd. i.
[5] Virchow's Archiv, Bd cxii., S. 70.
[6] Beit. z. klin. Chir., 1887, S. 165.
[7] Centralbl. f. Chir., 1893, S. 307.

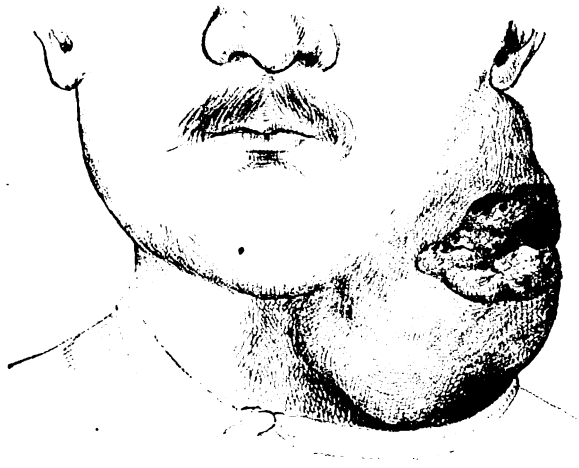
develop by preference in males between fifty and sixty. These cervical carcinomata first appear between the hyoid bone and larynx on the one hand and the vascular trunks on the other, often as tumors of stony hardness. Even when the growth has attained large dimensions, the integument and pharyngeal wall can be freely moved over its surface. A section from the tumor is at this time like that from a cancerous mamma. When retrograde changes and the softening incident thereto have occurred, the tumor may be converted into an irregular fluctuating mass of large dimensions, widely separating the air-passages from the blood-vessels and extending, as in the first of Volkmann's cases, quite to the base of the skull. Figs. 1716 and 1717 are from drawings made by Dr. De Beck of a case operated on in 1884 at the Good Samaritan Hospital, in which more than an inch of the internal jugular vein was removed. The patient succumbed to recurrence eight months after the operation. Microscopic examination revealed the epithelial character of the growth. The stroma consisted of firm fibrous bands. In the three cases reported by Volkmann, death from secondary hemorrhage followed soon after the operation.

Fig. 1716.

Carcinoma of Neck.

The secondary carcinomata of the neck are the result of direct infection from primary disease of the lips, tongue, fauces, air-passages, or mamma. The predilection of this disease for the region of the oral cavity explains the greater frequency of carcinoma of the neck in the submaxillary triangle. The lymphatic glands are first involved. For a time they appear as distinct tumors, freely movable on each other and without attachments. Afterward a peri-adenitis ensues, probably from added purulent infection. Glands, mus-

Fig. 1717.



Carcinoma of Neck.

cles, fasciæ, and integument are welded together in a mass of leathery firmness. Softening occurs at one or more places, and from the resulting ulcers or sinuses issues a characteristic fetid discharge. In carcinoma of the breast the implication of the cervical lymphatics may precede that of the axillary.

CYSTS OF THE NECK.

Within solid growths of the neck of epithelial, connective-tissue, or glandular origin, cysts often develop. Aside from those which are secondary, there are many tumors in which from the very beginning the characteristics of a primary cyst are present, that is, a well-defined investing membrane lined with one or more layers of cells, and more or less fluid contents. Thanks to the labors of Hawkins, Voillemier, Roser, Schede, Madelung, Wagner, Lannelongue, and others, a division of cervical cysts according to their etiological development is now feasible. They may be divided into: (1) Cystic enlargements of bursæ, or hygromata. (2) Branchial cysts. (3) Lymphatic. (4) Sanguineous. (5) Hydatid.

HYGROMA.—In the mid-line of the neck, in relation with the hyoid bone and thyroid cartilage, are a number of true bursæ to facilitate the movements of the larynx and the play of the muscles above. These are the bursa subhyoidea, the bursa prethyroidea, and the bursa suprahyoidea. The *bursa subhyoidea* (Boyer), present in all subjects and larger in men than in women, is situated beneath the hyoid bone and the muscles attached to it from below, and in front of the thyro-hyoid membrane. The *bursa prethyroidea*, often absent, and present as a well-developed bursa only in old male subjects, is found between the deep fascia and the incisure of the thyroid cartilage. Corsen[1] found it present six times in twenty-five subjects. In five children examined it was altogether absent.

The *bursa suprahyoidea* (Verneuil) lies between the upper surface of the hyoid bone and the insertion of the genio-hyoid muscles. This bursa is not often found, and when present is prone to hygromatous change (Gruber). Enlargement of these bursæ, appearing in frequency according to their order given, manifests itself by a median swelling rarely exceeding a walnut in size, though Gruber describes one of the suprahyoid bursa as large as an orange. Globular in shape, often densely filled, and always attached to and moving with the underlying structures, they present a uniform surface, and when not inflamed cause no distress. Spontaneous rupture or imperfect removal gives vent to the bursal contents, which are clear, of yellowish tint, and very viscid. A tubercular character has not yet been recognized for the cervical hygromata. While the bursal sac remains, a cure is never effected. There remains a long fistulous track, which can be felt as a firm cord underneath the integument and from which mucoid discharge continues indefinitely.

For the relief of cervical hygromata a simple incision rarely does more than establish the obnoxious condition just described. In exceptional

[1] Corsen: De la Burse préthyroide (Thèse), 1877. (Quoted by Koenig.)

cases tapping, with subsequent injection of tincture of iodine, has been followed by cure. Complete excision is the only radical measure of relief. When a fistulous track is all that remains of the bursa, thorough curetting should be resorted to. In one of three cases which I have seen, this treatment was followed by permanent closure. In the event of its failure, complete excision of the fistulous track must be attempted. It should be borne in mind that the subhyoidean bursa is frequently bilocular, and that the fistulous track at its upper end may be bifid, the branches turning away from the mid-line beneath the hyoid bone.

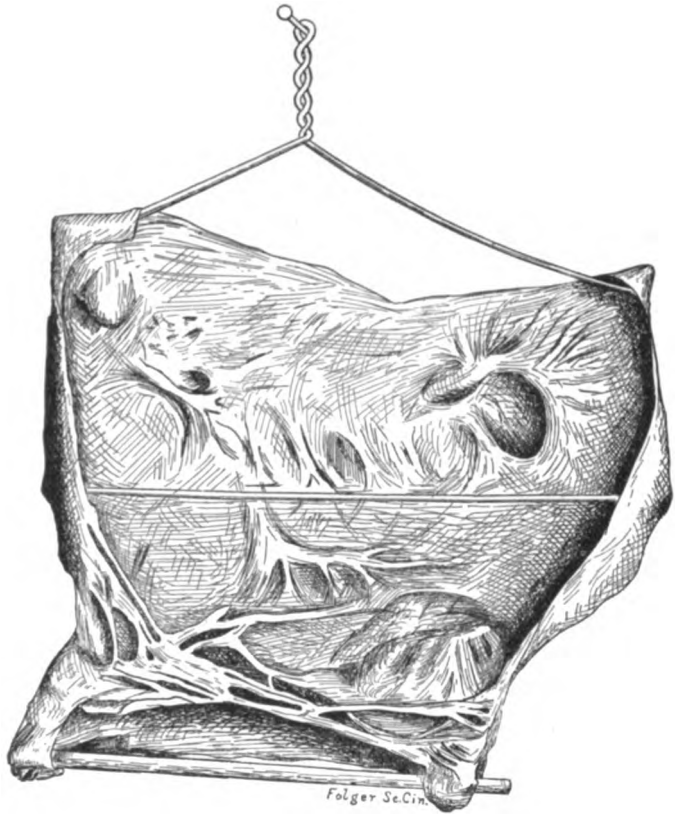
BRANCHIAL CYSTS.—Closely allied to the congenital cervical fistulæ described in Sir George Macleod's article are the cysts which since Roser's observations are generally denominated branchial. Schede found a cervical fistula in one and a branchial cyst in the other of twins. The lateral walls of the pharynx, in the first month of fœtal life, are formed on each side by four arches, decreasing in size from above downward and having between them furrows which, according to recent investigations of His and Kölliker, are generally kept from being fissures by a very delicate obturator membrane destined to separate the epiblastic and hypoblastic epithelia. With the exception of the first, from which the auditory meatus, tympanum, and Eustachian tube are formed, the branchial furrows are obliterated by the end of the eighth week. On the one hand imperfect obliteration may give rise to a branchial fistula. Retention, on the other hand, of epiblastic or hypoblastic epithelium beneath the integument, forms the matrix for the formation, early in life or under the developmental activity of the period of puberty, of cysts which bear certain fixed anatomical relations. Although in very rare instances they may occupy the median line, they generally occupy a lateral position, being deep-seated, between the angle of the jaw and the lower border of the larynx. In rarer instances they occupy a lower position in the neck. Since the styloid processes, stylo-hyoid ligament, and greater and lesser horns of the hyoid bone are formed from the branchial plates, these cysts often have more or less firm attachments to the parts named. Primary or secondary adhesions are likewise formed to the sheath of the large vessels of the neck.

Particularly when punctures or irritant injections have been resorted to, these adhesions may be firm. They affect chiefly the jugular vein, which more than the artery is exposed to injury in extirpation of the sac. Langenbeck has seen a branchial cyst project into the pharynx. When developed above the hyoid bone, the tumor often projects into the floor of the mouth. Many cases of ranula occurring in the young are doubtless branchial in origin. Externally, branchial cysts are covered by the deep fascia and the sterno-mastoid muscle. Anatomically they are unilocular, but may present a bilobed appearance when indented by a muscular or fascial band. The sac itself consists of thin connective tissue, and may be quite vascular. Forming the innermost layer of the sac-wall is a layer of pavement or columnar epithelium, or both. The thickness of the wall of the sac and of its epithelial strata is directly proportionate to the density of its contents. These may be mucoid, serous, or sanguineous, of the caseous character of an atheroma, or identical with those of a true dermoid. In the latter case

the sac-wall will posses all the elements of the *cutis vera*. The contents then for the most part consist of an epithelial detritus. Teeth are rarely found. In a number of cases the cyst has been found to be a true teratoma containing hair, teeth, and irregular masses of bone or cartilage, while in other cases isolated masses of cartilage have been found.[1]

When the cyst has for a long time remained latent, its contents may become oleaginous.[2] In the serous cysts they may be perfectly limpid, and, the cyst-wall ordinarily being very thin, the tumor may

Fig. 1718.



Branchial Cysts.

appear translucent (hydrocele of the neck). The cysts illustrated in Fig. 1718 contained a clear watery fluid, a few flat epithelial cells, cholesterin crystals, and a trace of albumin.

Anatomically these cysts are benign, but cases have been recorded in which, from proliferation of the glandular element of the cyst-wall, a malignant element has been added. Samter[3] recently reported a case of this nature in which local recurrence and metastases in the abdomen caused death.

Hemorrhage into a serous branchial cyst not infrequently occurs,

[1] Buttersack, Virchow's Archiv, Bd. cvi., S. 206.
[2] Malherbe, Bull. de la Soc. Chir., 1878, p. 257.
[3] Virchow's Archiv, Bd. cxii., S. 70.

thereby changing it into a sanguineous cyst. Cysts which at their first tapping yield a limpid fluid often at subsequent explorations have become sanguineous. Coagulation of the blood does not take place. In a few cases the cysts communicate with one of the larger veins by a vessel of considerable calibre. It must always remain a question whether such cysts are branchial or of the primary sanguineous character described below.

Although branchial cysts are clearly abnormal developments of rudimentary epithelia, and therefore in a pathological sense are always congenital, they are not as a rule present at birth. Nearly sixty per cent. appear between the tenth and thirtieth years. The first decade of life furnishes about sixteen per cent. of the cases, but no age is exempt.[1] Women are oftener than men the subjects of branchial cysts, and the left side appears to be oftener affected than the right.

Development, usually slow in the dermoid forms, may be very rapid in the serous. The case presented in Fig. 0004 was of less than four weeks' growth. To attain the size of a fist, from one to three years are ordinarily required, during which long periods of quiescence may be observed. Except from their pressure-effects branchial cysts produce no symptoms. When developing toward the floor of the mouth they give rise to great distress by pressure on the tongue. When developed near the hyoid bone their growth is downward and toward the surface. In the few cysts observed above the clavicle, the pressure effects have likewise been little marked.

Branchial cysts are perfectly outlined, soft, fluctuating, and free from pulsation except that which may be imparted from the underlying carotid. The integument, fascia, and muscles overlying them can be freely moved upon them, and they in turn to a much less extent on the tissues underneath. When there are attachments to vascular sheaths lateral movements are possible, while those in the line of the axis of the body are altogether abrogated.

The progress of branchial cysts is altogether benign, though chronic. Rupture may take place spontaneously or may follow suppuration induced by injections or tapping. Such an accident generally leaves a very obstinate fistula, the occasional closure of which will probably entail a reproduction of the cystic tumor.

Treatment.—The rational treatment of branchial cysts is the radical one of total extirpation. The difficulties encountered are in the rupture of the sac before the operation is completed, and in separating adhesions to the larger veins. The former accident may generally be avoided by keeping the knife well without the sac-wall, and by making the first incision of sufficient length. In almost every case it will be necessary to dissect the cyst from the vascular sheath. The internal jugular vein may be wounded at this stage of the operation, necessitating a lateral ligature, or division of the vein between two ligatures. When total extirpation is not feasible, what constitutes the attached base of the sac may be deprived of its epithelium by curetting, and then left *in situ*.

Other methods of treatment are tapping, injection of iodine, aseptic drainage, and partial resection with packing of the wound. In exceptional cases, as in young children, one or other of these methods may be tried. It may be said of them all that in their end results they are un-

[1] Schede, Arch. f. klin. Chir., Bd. cxiv., S. 1.

certain, and quite as dangerous as extirpation. When they have been tried and have failed, subsequent extirpation is rendered far more difficult.

LYMPHATIC CYSTS.—These have been briefly described in a previous volume of this work[1] under the heading of *compound congenital cysts*. They may be unilocular or multilocular. When the cyst is single, it may be impossible to distinguish it from one of branchial origin if found in the anatomical position of the latter. The lymphatic cysts are found in any part of the circumference of the neck, immediately underneath and involving the integument, or sub-fascial and in their growth displacing muscles, vessels, and nerves, or invading the former. A favorite site is the nucha, the cyst then resting on the cervical spine, which divides it into symmetrical halves. When occupying the front of the neck, the processes of the cyst may project into the floor of the mouth, involve the base of the tongue, and extend over the maxillary border to the face, but never, according to Lannelongue, beyond the line joining the labial commissure and the auditory meatus. In their downward growth the compound cysts may involve the mediastinum. The contents of these cysts are ordinarily clear and limpid, containing a few leucocytes and a marked proportion of albumin, from four to eleven per cent. The larger blood-vessels which are found within the cyst-wall may through rupture change the character of the contents of some of the cysts.

A number of theories has been advanced as to the primary source of these congenital cysts. Since the investigations of Wegner,[2] Middledorf,[3] and Lannelongue, it is quite certain that these tumors spring from aberrations of the lymphatic vessels, and that they may be regarded as cavernous lymphangeiomata. They are often associated with other lesions of the lymphatics, such as macroglossia or macrocheilia. After spontaneous rupture or operative interference long-continued lymphorrhagia has been observed. In very exceptional cases cystic lymphangeiomata have developed later in life.

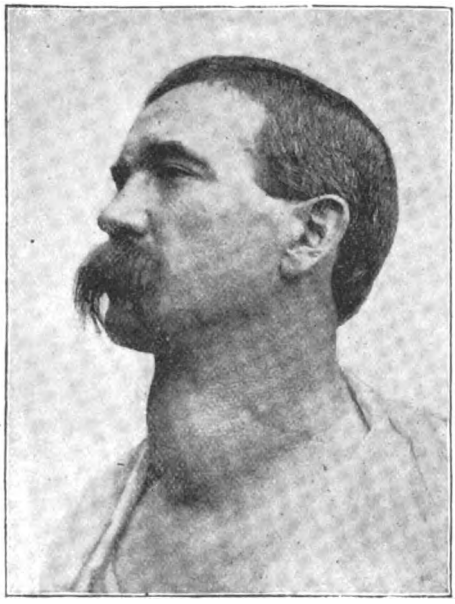
The *symptoms* produced are those from compression, and when the cysts are superficial they may be negative. In cases of extensive and deep-seated cysts, respiration and deglutition are interfered with to such an extent that death ensues within a few months of birth, from œdema of the glottis or from inanition generally. In a few cases, involving limited areas, spontaneous cure has followed rupture of the sac.

The *treatment* of this condition must ordinarily be palliative. The radical treatment by extirpation is feasible in children only when the tumor is small. Should rapidity of growth or the effects of compression threaten the life of the child, multiple punctures may be resorted to with a view to the reduction of the tumor in size, and the definite obliteration of a number of the cysts. The injection of irritating fluids, such as the tincture of iodine, may be resorted to in properly selected cases. The use of permanent drainage promises much in these cases, provided that wound infection can be avoided. In older children and in adults total extirpation is indicated, unless the necessary dissection would pass the limits of operative safety.

[1] Vol. V., p. 200, *supra*.
[2] Archiv f. klin. Chir., Bd. xx., S. 641.
[3] Ibid., Bd. xxxi., S. 590.

SANGUINEOUS CYSTS.—A cyst containing blood may develop from an encapsulated hemorrhage, or from bleeding into a solid tumor or a cyst primarily serous and branchial. Other cysts are sanguineous from their inception, and owe their development to anomalies of the large venous trunks or lymphatics of the neck. Although they may be found in any part of the neck, these are generally in relation with the internal jugular or subclavian vein. In three out of eleven cases which have been carefully investigated by Franke[1] and reported by Koch, Hueter, and Baiardi, the subclavian vein was not found in one, and the internal jugular in two of the remainder. In a larger number of instances the cyst is connected with one of the veins by a trunk of considerable diameter. In the patient from whom Fig. 1719 was obtained, the deep surface of the cyst was adherent to the internal jugular, and from its lower portion there ran to it a branch nearly an inch long and as large as the temporo-maxillary vein. In other cases the cyst appears to be a varix which has become separated from the parent vein and stands in no relation with any large trunk. Its growth is not thereby interrupted since, according to Virchow,[2] it is fed by a number of small branches which empty into the sac.

Fig. 1719.



Sanguineous Cyst of the Neck.

Anomalies of the venous and lymphatic vessels must account for yet other cases, since there may be in the same patient a number of small lymphatic cysts within the wall or just without the principal, sanguineous cyst. In the case above alluded to this condition was found. Four or five of these cysts, varying in size from a pea to a hazelnut, were incised and discharged a clear serous fluid. Finally, an angeioma which is not in connection with any large vein may by absorption of its septa become converted into a sanguineous cyst. Bell[3] recognized this possibility, and reported such a case. In a youth of seventeen recently operated on at the Good Samaritan Hospital, a sub-fascial encapsulated angeioma of the submaxillary region, projecting into the floor of the mouth, consisted largely of a central cyst, the walls of which seemed formed of the remainder of the vascular growth. It had no connection with any large vessel.

The cyst-wall, generally rather adherent to its surroundings, may measure from one-twentieth to one-sixth of an inch in thickness, and is rarely of equal thickness throughout. Within it the three coats of the vessel have been found.[4] The internal surface varies in appear-

[1] Deutsch. Zeit. f. Chir., Bd. xxviii., S. 411. [2] Geschwulstlehre, Bd. i., S. 154.
[3] Principles of Surgery, vol. iii., p. 399. London, 1796.
[4] Meyer, Centralbl. f. Chir., Bd. lxxxix., S. 663.

ance. In a specimen obtained from a female aged thirty-four (Fig. 1720), some parts were smooth and glistening like the endocardium, while others presented irregular elevations and trabeculæ which traversed the cavity and were as large as, and very much like, the chordæ tendineæ. In other places the surface presented the appearance of an erectile tissue. A very distinct endothelial layer was found over most of the internal surface of the cyst.

The contents of a primary sanguineous cyst are fluid, and as a rule not coagulable. According to Paget[1] the blood which finds its way into a serous cyst is either partially or wholly coagulated, and more or less decolorized.

Primary sanguineous cysts as a rule appear congenitally, or during the first decade of life, although they may appear at the other extreme. They are of slow growth and may for a long time remain stationary, or, on the other hand, they may in a few weeks assume enormous proportions, rapidly extending from mastoid process to clavicle. Disappearance of the tumor or decrease in size by compression can only be effected in a minority of cases. Even when at the operation large connecting veins have been found, the tumors have been irreducible. Only when deep-seated do they give rise to distressing symptoms by pressure on the pharnyx or larynx, into which they have been known to rupture (Vincent,[2] Savory).[3] After puncture, these cysts refill very rapidly with blood. Even after aspiration of a serous cyst a threatening hemorrhage into the sac occurred in Mr. Birkett's hands, and by recurring after each puncture produced extreme anæmia.[4]

Fig. 1720.

Sanguineous Cyst of the Neck.

The *treatment* of sanguineous cysts was until recently limited to tapping and the injection of irritating or coagulating fluids. Richardson[5] reports a case successfully treated by the injection of perchloride of iron. This treatment is contra-indicated for cysts from which a connection with a venous trunk can be established by pressure, and since such a connection often exists without being demonstrable by so coarse a test, it is doubtful whether injection ought ever be practised. Acupuncture and electrolysis have likewise been resorted to with unsatisfactory results. Aside from their uncertainty, the danger of sepsis from either of these methods is very considerable. Woerner[6] has quite recently reported a death from the injection of iodine.

The radical measure of total extirpation should be preferred to other procedures, unless the size of the growth or the age of the patient would make the operation more than ordinarily hazardous. In one of Volk-

[1] Surg. Path., p. 413, 1870.
[2] Quoted by Paget, op. cit., p. 404.
[3] Lancet, Nov. 24, 1866.
[4] Med.-Chir. Trans., vol. li.
[5] Dublin Quart. Journ. Med. Sci., Nov., 1869.
[6] Beitr. z. klin. Chir., Bd. i., H. iii.

mann's cases the tumor extended to the base of the skull, and could not be removed. In other cases the cyst extends into the chest and is beyond surgical intervention. Volker has collected nine total extirpations by German surgeons. I have performed the operation in three cases, without any untoward symptom at the time of excision and without subsequent complication.

HYDATID CYSTS.—Hydatid cysts of the neck are rare. In 1882 Riedel could collect but fifteen cases. They were uniformly developed in the side of the neck between the mastoid process and the clavicle, and in relation with the large blood-vessels. Although the hydatid cyst may be superficial, it generally has a deep origin and grows toward the surface. In its progress it may entail much destruction of tissue. When the cyst is superficial and thin-walled it may be translucent, but when deep-seated even fluctuation may be indistinct. In not a few cases suppuration of the cyst has caused it to be taken for an abscess. The removal by puncture of the characteristic fluid of a hydatid and of its hooklets, determines the diagnosis.

The *treatment* of a hydatid must aim at its destruction, which is best accomplished by free incision and drainage. The consequent suppuration, which in itself is curative, must be restricted. While primary enucleation of the sac may at times be successful, surgeons familiar with the disease do not recommend this as a practice to be adopted in many cases.

SURGICAL AFFECTIONS OF THE THYROID GLAND.

THYROIDITIS.—A vascular engorgement of the thyroid gland is often seen with menstruation, during pregnancy, and in young girls while the menstrual function is being established. In the latter the swelling is at times sufficient to constitute a form of acute goitre. Aside from the swelling and tenderness there are no evidences of inflammation. The normal thyroid gland being enclosed in a firm capsule, having no excretory duct, and a low functional activity, is protected against the invasion of the organisms of inflammation unless introduced through its blood supply. True inflammations of the normal thyroid gland are therefore rare. In the goitrous gland the disease is more common. To designate this class of cases the term "Strumitis" is often used. With the exceptional facilities for observation offered in Switzerland, Lebert saw but nine cases.

Thyroiditis is the result of infection from without or from within. Wounds of the gland, aspiration of cysts, interstitial injections with unclean instruments, or extension by contiguity of morbid processes from larynx or trachea, are among the external causes. Infection of the gland from internal sources may occur during any of the acute infectious diseases. It has been observed after pneumonia, malaria, diphtheria, and relatively often after typhoid fever. In the puerperal state thyroiditis may be the first and chief evidence of sepsis. As part of a pyæmic process abscess of the thyroid has often been observed. Thyroiditis of rheumatic origin has been described by a number of authors. It may develop during the height of the articular disease, may precede, or may follow it.

The previous existence of a goitre predisposes to inflammation of the gland. Lebert saw all of his cases in Zurich, where goitre is endemic, but none in Breslau. Kocher[1] reports 24 cases of strumitis, in 11 of which aspiration, electrolysis, or interstitial injections had been practised. In 6 of the remaining 13 cases some of the causes already mentioned were found, and Kocher directs attention to mild catarrhal affections of the alimentary canal as predisposing to the disease in question. Of suppurative thyroiditis two cases have come under my observation; one acute, in a previously normal gland as a sequel of typhoid fever; the other chronic, and following the retention of the needle of a hypodermic syringe.[2]

Suppurative thyroiditis is always of microbic origin. Eleven cases examined in this regard showed the presence of eight different species of bacteria. Besides the ordinary pus formers found by Wölffler in 1883, the presence of the pneumococcus was demonstrated by Gerard and Marchant;[3] of the bacterium coli commune by Brunner,[4] and of the typhoid bacillus by Favel and Kummer.[5]

Non-suppurating thyroiditis may involve the entire gland, while the purulent form is generally limited to one lobe. Abscesses may be superficial or deep; single or multiple. In the latter cases intensely vascular gland tissue will be found between the foci. The tendency of thyroid abscesses is to point externally. Retention of pus beneath the cervical fascia sometimes leads to mediastinal inflammation. Perforation into the trachea is not very rare, but rupture into the œsophagus is less common. In fulminating cases of thyroiditis gangrene may develop, with retention of the gases of decomposition.

Symptoms and Course.—The symptoms and course of thyroiditis are largely influenced by the cause, and by the previous state of the part. Developing in a hitherto normal gland, an inflammation of malarial, rheumatic, or typhoid origin is comparatively mild. Often inaugurated with a chill, the disease makes itself manifest through elevated temperature, rapid pulse, dry tongue, and anorexia. When, as is the rule in these cases, the entire gland is involved, a characteristic swelling appears in the place of the normal thyroid, on both sides and in front of the trachea. The swelling may often be felt by palpation before the tumefaction becomes visible. In well-developed cases the tumor is as large as a peach, or a fist, and its lower border may then be beyond reach, extending below the sternal notch. The tumor, always tender, moves with the trachea. The overlying soft parts glide freely upon it. The size of the swelling determines the local symptoms, which are chiefly those of compression. Moderate dyspnœa from pressure on the trachea is common. There is usually some huskiness of voice or spasmodic cough from compression of the recurrent nerves. Pressure on the veins may produce a cyanosis of the neck and lower portion of the face. Epistaxis and hæmoptysis have been observed. When the swelling is large, radiating pains may be felt in the course of the lower cervical nerves. The symptoms of compression are most marked in cases of strumitis proper. In the milder forms of the disease the conditions described are developed within from four days to a week; they remain

[1] Arch. f. klin. Chir., Bd. xxiii., S. 113. [2] Annals of Surgery, October, 1894.
[3] Cong. Chir. (France), 1891, p. 268. [4] Schweiz. Corresp.-Bl., 1892, Bd. xxii., S. 307.
[5] Wien. med. Presse, 1891, Bd. xxxii., S. 1620.

stationary for another week and gradually subside. In rare instances a residuum of the vascular engorgement forms the basis of a goitre. When suppuration ensues, the general and local phenomena are those of suppuration elsewhere. The rapidity with which the presence of pus is manifested varies within wide limits. In the acutest forms agglutination of the overlying soft parts and perforation of the capsule ensue in from two to three weeks. Sloughing of the gland from excess of intra-capsular tension has been observed as early as the tenth day. When the "dosage" of infection has been slight, as from the use of unclean instruments, weeks and months may pass before the abscess perforates the capsule. Such cases may assume from their inception a subacute or even chronic course. The rapidity with which pus is evacuated also depends on the depth of the abscess. The ways in which it may travel have already been mentioned.

The spontaneous or operative evacuation of the abscess speedily leads, as a rule, to permanent closure by the granulation process. In the more subacute cases, the capsule of the abscess, or that of an entire lobe thickened by prolonged vascularity, and the presence of flabby granulations within, may for a long time or indefinitely prevent healing. There remains an obstinate fistula leading to the abscess, or if closure does ensue, retention with its usual concomitants follows.

The *prognosis* of thyroiditis depends largely on its cause. Always of considerable gravity in suppurative cases, it becomes very grave as a complication of puerperal infection, pyæmia, or diphtheria. When suppuration develops in a goitre which by its size and attachments has compressed the trachea or blood-vessels, the increased pressure may speedily cause death. Other causes of a fatal issue are acute sepsis, hemorrhage, and exhaustion from prolonged suppuration. According to Lebert, suppuration ensues in over sixty per cent., and twenty-five per cent. of all cases are fatal.

The *treatment* of thyroiditis in its beginning must be directed toward the prevention of suppuration. Internally, the salicylates and large doses of saline cathartics may be administered. Externally, leeches may cut short the attack, and Brieger reports cases of diphtheritic thyroiditis thus aborted. The continued use of ice-bags may delay or even prevent suppuration. Kocher recommends the interstitial injection of carbolic acid. When pus is present operative interference is indicated. If the abscess is superficial, a free incision must be made and drainage secured. In deep-seated abscess aspiration may first be resorted to, lest the cutting through a thick wall of gland tissue should cause hemorrhage which in the debilitated condition of the patient might prove fatal. Whether the abscess be superficial or deep, its evacuation will often be followed by bleeding profuse enough to demand tamponing the abscess cavity with gauze. When multiple abscesses exist they may generally be emptied through a single incision.

In very acute cases suffocation may be threatened before an abscess has been formed. Tracheotomy must then be resorted to, and a cannula of more than ordinary length must be employed.

Excision of the abscess cavity, with the lobe of the gland in which it is contained, must occasionally be resorted to in chronic cases in which obstinate suppuration and recurrent hemorrhages threaten the life of the patient.

GOITRE.—This term has been and still is loosely used to designate all chronic enlargements of the thyroid gland. It should be, and in the following pages is, reserved for such enlargements as are primarily of epithelial origin, clinically benign, and except through their mechanical effects on contiguous parts devoid of serious consequences.

Site.—Goitre may involve both lobes of the gland and the intervening isthmus. It may develop in one or other lobe, in the isthmus alone, or in an accessory lobule. Recent investigations into the development of the normal gland have shown that accessory lobules are often found, and that they vary in size from a lentil to a bean. The limits of their distribution are the mandible above and the aortic arch below, on either side of the sterno-mastoid muscles. Posteriorly they have been found between the trachea and gullet, and even behind the latter. Such accessory lobules are generally situated in close relationship to the normal position of the body of the gland, and are often connected with it. They are continued downward, toward or behind the sternum, in contact with the vascular and nervous trunks of the root of the neck. Through abnormal development, the gland may completely surround the trachea and form a partial or complete canal for the passage of the œsophagus. On the other hand, the accessory lobules may have severed all bonds and exist as independent islets of glandular tissue, far removed from the parent gland. Their existence accounts for the presence in rare cases of intra-laryngeal and sublingual growths of typical thyroid structure. Gruber and Madelung have attempted to divide these accessory glands into certain groups. To their presence is due the atypical situation of some goitrous tumors, and they modify the form of enlargements of the body of the gland.

Pathology.—The normal thyroid is a lobulated gland contained within a vascular and fibrous capsule, from which connective-tissue septa penetrate the interior and separate the lobules from each other. The latter consist of the ultimate granules imbedded in a stroma of interstitial connective tissue, derived from the capsule of the gland. The granular follicle is a minute globular sac of basement membrane, lined and filled with nucleated cells of gland type. In the adult gland the centre of the follicle generally contains a deposit of gelatinous or colloid material. In addition to the elements contained within the follicles, Wölffler has found vestiges of epithelial embryonal cells in the stroma, between the acini of the gland, and believes that when stimulated to exuberant growth these masses of latent cells are productive of goitre. This view of Wölffler on the histogenesis of goitre has not, however, found general acceptance, and until further proof thereof is adduced, the doctrine of the intra-follicular origin of struma, as particularly enunciated by Virchow, may properly be retained. Every goitre is primarily epithelial, and the varieties are due to secondary changes consequent on cell metamorphosis, connective-tissue sclerosis, vascular hyperplasia, and hemorrhages. The shape, size, consistence, and surface appearance, in brief the clinical phenomena of a goitre, are determined by the variety to which it belongs, as is also the question of operative interference.

Varieties.—(1) *Follicular Goitre; Struma Hyperplastica Follicularis et Parenchymatosa.*—This represents a growth of moderate dimensions. It is generally diffused throughout the entire gland or one of its

lobes; it is soft, often slightly lobulated, presenting to the touch islands of greater resistance within. On section it resembles macroscopically the normal thyroid tissue. This follicular goitre is essentially a proliferation of the follicular cell elements, whereby the follicles themselves are enlarged and their number increased. Irregularity in the growth of the cell masses causes nodular or cord-like excrescences from the parent follicle, from which in their further development they become entirely separated. Stimulated to activity by the cell proliferation, the interstitial connective tissue provides a capsule for these isolated masses. New and larger follicles are thus produced. Irregularities in the growth of the new cell masses and follicles, the limitation of the process to one part of the gland, and the difference in age of the new formed tissue, will give a nodulated appearance to the follicular goitre. Whether single or multiple, the presence of the nodules of soft consistence is of sufficient clinical importance to warrant for follicular goitres containing them the term nodular goitre, or *struma nodosa.*

The follicular goitre may continue as such indefinitely. As a rule, however, the follicular hyperplasia is followed by secondary changes in the stroma, the vascular supply, or the follicular cell elements themselves, thus giving rise to further varieties of the disease.

(2) *Fibrous Goitre.*—Responsive to the irritation of the proliferating follicles, the connective tissue of the follicular walls and of the stroma participates in the hyperplasia. The development of new interstitial tissue may proceed rapidly until the goitre is pervaded by fine inelastic masses of fibrous tissue. In places the follicular element is entirely supplanted by hard fibrous nodes, varying in size, of white or yellowish color, creaking under the knife, almost devoid of blood-vessels, and on section resembling the structure of the semilunar cartilages, and quite as firm.

Hence the name formerly given of scirrhous or cartilaginous goitre. The sclerotic masses vary greatly in size and in number. From the size of a filbert they may grow to that of a hen's egg. When single, they send fibrous prolongations toward the periphery; when multiple they are joined together by similar bands. The fibrous node is often surrounded by a layer of proliferating vascular gland tissue.

The fibrous goitre is generally nodular, limited to one or other lobe, or to part thereof, and by itself does not give rise to a tumor of large size. Occasionally, however, sclerosis of the entire gland is followed by dire results through compression of the trachea, although the goitre itself may appear quite small.

(3) *Vascular Goitre.*—The influence of vascular engorgement on the size of the thyroid gland is manifested in certain physiological states, such as menstruation, sexual excitement, and pregnancy. An increase in the number and volume of its blood-vessels belongs to every goitre. It is only when there is a preponderance of vessels over glandular growth that the term vascular is applicable. The increase in the number and size of the vessels may affect the arteries or the veins.

Following the lead of Virchow, writers speak of an arterial or aneurismal goitre, and of a venous or varicose goitre. In the former the arteries are uniformly dilated and their anastomotic branches greatly increased in number. There is no tendency to the formation of saccular dilatations. The vessels involved are chiefly those displayed on the

capsule of the gland, and those just within. They are elongated, assume a tortuous course, and very often present a corkscrew-like arrangement where they enter the parenchyma of the gland. In extreme cases the vascular condition resembles that of a cirsoid aneurism. It may be congenital (Haidenhain), or may form the important element of a goitre of adult life.

The varicose goitre is more common than the variety just described. It affects the intra-capsular as well as the extra-capsular veins. In the soft nodular masses of the follicular goitre, irregular dilatations in the periphery of the nodules are far from common. As sources of hemorrhage into, and consequent sudden enlargement of, the goitre, these dilated veins and the ampullar pouches connected with them are important factors. It is, however, in the peripheral veins that the varicose condition is most marked. Here the vessels appear as sinuses, often as large as a pencil or the finger, winding in their course, and displaying numerous diverticula of varied form and size. Such varicosities are mostly observed in large goitres of long duration.

(4) *Colloid and Cystic Goitre.*—This form of goitre follows a colloid degeneration of the epithelial cells of the follicles. It generally attains large dimensions. On section the gland presents one or more large cavities filled with a thick, gummy, yellowish, jelly-like material, removed with difficulty, and rich in albumin and sodic and kalic chlorides. Before extensive colloid changes have ensued the primary glandular structure is retained, the lobules appearing larger and containing within their centres a gelatinous mass. Even in larger cavities vestiges of cylindrical cells are to be detected. Similar masses of unchanged cells are often found within the gelatinous material, by proliferation of solid cell masses from peripheral layers. In this way smaller cysts are often formed within the larger. Primarily as large as a lentil, the gelatinous masses increase in size with the degeneration of the new-formed cells. The inter-acinous stroma and its blood-vessels atrophy from pressure, and thus contiguous cysts are fused. Through repetition of this process the number of cysts in the goitre may be reduced until only one large cyst remains, which by the imperfect septa within discloses its origin from many.

The metamorphosis of some of the epithelial cells results in cholesterin production. This is often extensive enough to give the cyst contents a sebaceous character. Through deposit of lime salts they are in rare cases converted into calculi. The contents of large cysts often present a grumous appearance, of chocolate or even darker color, from the admixture of blood. The hemorrhages may result from the erosion by pressure of a varicose vein, from trauma, or as the result of a puncture. If the bleeding is abundant coagulation may follow, but otherwise the blood is diffused throughout the gelatinous material, causing it to resemble very closely the grumous contents of an ovarian cyst.

While from the foregoing account it is seen that colloid degeneration leads to cyst formation, a cystic goitre may develop in another way. Without the formation of colloid, an accumulation of an albuminous fluid occurs within the follicles, the cells undergoing usually a fatty degeneration. The single follicles increase in size, the connective tissue walls atrophy as above described, and many small cysts become

confluent. The increase in size is not altogether dependent on fusion, the cyst wall itself yielding a copious serous transudation. After evacuation of a cyst by puncture it may refill within a few hours or days, and in this way the rapid growth of some goitres is explained. In the cystic goitre here described the contents, if unchanged, are aqueous, clear, highly albuminous, and slightly yellowish or greenish in color, much resembling the fluid of a hydrocele. Large and thin-walled cystic goitres are therefore translucent if the cysts are superficial and their contents unchanged. Gelatinous and cystic goitres are usually large, and often are pendulous masses extending to the root of the neck, or over the sternum, to the line of the nipple or as low as the abdomen. According to the number of cysts, the tumor presents a smooth or lobulated surface.

The varieties of goitre described are those ordinarily encountered, and in small tumors they exist separately. In those of many years' standing, however, there is often an admixture of the various secondary changes, giving to the mass, on section, a great diversity in appearance. While one form may and usually does predominate, the others are represented.

Surrounding the glandular or fibrous nodules, and the cysts of various form, is a layer of connective tissue called the capsule of the goitre. This is separate and distinct from the capsule proper of the gland, with which in superficial nodules it may become partly fused. On the outer surface of the capsule there is often, even in comparatively superficial nodules, an atrophied layer of gland tissue. As the capsule grows in thickness it becomes poor in blood-vessels. In very rare instances it is so extensively infiltrated with salts as to resemble osseous tissue. According to Virchow [1] true bone is never found in the goitrous capsule.

In justice to the extensive researches on the pathology of goitre made by Wölfflер, and above alluded to, I append the varieties of goitre as given by him in his most recent publication.[2]

(*a*) *Hypertrophy of the thyroid gland*, present at birth and developing at puberty or during pregnancy, uniformly enlarging the entire gland. It is smooth on the surface. There are no nodules within. The normal contour of the gland is retained. Tumor is soft, and if very vascular, compressible.

(*b*) *Vascular goitre*, purely a clinical name, depending on the number of the vessels and in no relation to the glandular element. This goitre can often be emptied like a sponge. It pulsates visibly, vascular bruits are audible, and a thrill can often be felt.

(*c*) *Fœtal Adenoma.*—This is represented by a circumscribed tumor existing from birth or puberty. It is generally firm in consistence and movable, and often the tumors are multiple.

(*d*) *Adenoma gelatinosa*, or *colloid goitre*, often develops late in life, and appears as a soft, nodular, more or less fluctuating tumor of very slow growth. Occasionally the colloid material increases fast. Thence the *cystic goitre*.

Etiology.—The main data are given in Sir G. Macleod's article.[3] It should be added that the disease preponderates in women. Laycock found only 26 men affected in 551 cases, and Baillarger has tabulated

[1] Krankh. Geschw., Bd. iii., S. 41.
[2] Arch. f. klin. Chir., Bd. xl., S. 171.
[3] Vol. V., p. 204, *supra*.

13,090 cases of which 8484 were in women. In Billroth's clinic only twenty-six per cent. of the cases occurred in males. In women the goitre develops usually about the period of puberty, or during pregnancy. It may be congenital and develop rapidly at these periods of sexual activity.

In the endemic goitre of mountainous regions, affecting animals as well as human beings, the bad quality of the drinking-water seems to play an important part. Quite recently Lustig [1] has proclaimed goitre an infective disease produced by a specific germ found in the water, and claims to have isolated the germ and to have produced goitre in animals by giving them the infected water of the Aosta valley.

Symptoms.—Except for the physical deformity entailed, goitres often produce no marked symptoms. These depend largely upon the structure and situation of the tumor. Small fibrous goitres which closely surround the trachea, extend between the trachea and the œsophagus, or grow beneath the sternum and press upon the vascular and nervous trunks, give rise to more serious phenomena than very large and deforming goitres which hang as pendulous masses from the neck and cover the chest. Pressure upon the trachea, if unrelieved, may produce death from long continuance of dyspnœa, or from sudden collapse of the windpipe. Sudden deaths have overcome goitrous subjects, particularly often during sleep. According to Rose,[2] fatty metamorphosis and absorption of the cartilaginous rings make a compressible membranous tube of the trachea, which then easily collapses; but, according to most authorities on goitre, this danger is rare. Dysphagia is not a common symptom. When present, in ordinary cases, it indicates the existence of a retro-tracheal or retro-pharyngeal growth. In malignant goitre, on the other hand, œsophageal stenosis is very often produced. The large vascular and nervous trunks of the neck ordinarily escape compression by lateral displacement. Nevertheless the return of blood through the jugular is at times interfered with, and marked evidences of cerebral congestion are occasionally seen. Compression and irritation of the recurrent laryngeal nerve often induce paralysis of the vocal cord with aphonia, violent seizures of coughing, and at times very serious asthmatic attacks. The sudden death of goitrous subjects has been charged to the sudden bilateral paralysis of the vocal muscular apparatus. A very interesting complication of goitre is the tachycardia due to irritation of the sympathetic filaments contained within the goitre itself. Since in true Basedow's disease exophthalmos is often absent, the distinction between the surgical Basedow's [3] disease and the former may be difficult. In 1869 Eulenberg sought to differentiate the two conditions. As a result of unilateral goitre he observed exophthalmos, mydriasis, and elevation of the temperature on the side of the goitre. Stenocardial attacks, psychic phenomena, tremors, insomnia, and epileptic seizures belong to true and not to secondary Graves's disease.

The *diagnosis* of goitre ordinarily presents no difficulty. The position of the tumor, its lateral mobility imparted to the trachea, and its ascent during deglutition, are sufficiently characteristic. In exceptional cases, however, the goitre develops in abnormal places from ac-

[1] A. Lustig and A. Cade. (Quoted in Giorn. di R. Acad. di Torino, Agosto, 1890, p. 689.)
[2] Arch. f. klin. Chir., 1878, Bd. xxii. und xxiii. [3] Gauttier, Lyon Méd., 1888, No. 22.

cessory portions of the gland, or by its weight is drawn away from its original position, and retro-pharyngeal and retro-tracheal goitres are often difficult of diagnosis. Movable goitres, described by Wölffler, may sink or by aspiration be drawn into the mediastinum, behind the sternum or clavicle. Retro-sternal goitres may exist with or independently of a tumor of the normal gland. An accessory goitre may be mistaken for an enlargement of a cervical lymphatic gland, for a sanguineous cyst, or if situated in the median line for a ganglion. Owing to its inherent vascularity, or to its relation to the large blood-vessels, a thyroid tumor must sometimes be differentiated from an aneurism. A study of its relations, the mobility of the tumor, and the character of the pulsation, will exclude the possibility of error.

Treatment.—The internal therapy of goitre is restricted to the use of the preparations of iodine and of ergot. In very vascular tumors the internal use or interstitial injection of ergot has a beneficial influence in restricting the development and reducing the size of the growth. In parenchymatous goitres uniformly affecting the gland, of rapid growth and of recent date, iodine internally administered often produces rapid diminution of the tumor, and even in recent cases may cause its total dissipation. The external application of iodine and of ice-poultices, when long continued, appears to hasten the absorption of recent hypertrophic goitres. In the colloid and cystic goitres of older date, internal medication and embrocations are altogether useless. In the nodular form of goitre parenchymatous injections of iodine, iodoform, or alcohol, are frequently followed by induration and rapid diminution in size. Not more than from five to ten drops of alcohol or tincture of iodine are to be used for each injection. Of a solution of iodoform in ether and olive oil (1–7–7), Mosetig Moorhof injects from 15 minims to 1 drachm. Intra-thyroid injections necessitate certain precautions. The syringe should be sterilized and the needle strong. The patient being in the recumbent position, the tumor is seized and well fixed with the left hand, while, carefully avoiding superficial veins, the needle is driven to its hilt into the growth. The injection must be slowly made, to avoid the asphyxia or syncope which would certainly follow the injection of the entire dose should a vein perchance have been punctured. To avoid this possibility very careful operators first puncture the tumor with the needle of an empty syringe and aspirate the growth, the filling of the syringe with blood showing that a vessel has been entered, and necessitating a change in the position of the needle. If no blood enters, the barrel of the syringe is charged and the injection is completed. Injections into the thyroid are not generally painful, though momentary pains in the jaw, or under the ear, and a metallic taste are often experienced. The injections produce temporary increase in the size of the gland, but this reactionary swelling is rapidly followed by induration and diminution. The injections are to be repeated at intervals of from two to five days.

That parenchymatous injections are not devoid of danger has often been shown. The methods of aseptic surgery and hæmostasis having removed the chief danger from capital operations, intra-glandular injections are not now so much resorted to as even a decade ago. More radical operative procedures have supplanted them. Nevertheless, the mere existence of a goitrous tumor does not justify an opera-

tion, the indications for which may be summarized as follows: 1, Great deformity. 2, Suffocative attacks or continued dyspnœa. 3, Dysphagia. 4, Very rapid growth of the tumor.

Many variations of classical operations for thyroid enlargements have been devised by different surgeons. In the very elaborate article of Van Arsdale,[1] nine methods are described. Total and partial extirpation, resection, amputation, enucleation, and ligature of the afferent vessels, comprise the procedures from among which the procedure adapted to the individual case is to be chosen. Total extirpation should be reserved for malignant disease of the thyroid gland. In the ordinary varieties of goitre it can no longer be considered justifiable, though not because of the immediate mortality of the operation, for this has steadily decreased. Thus, according to Wölffler, 50 thyroidectomies prior to 1850 were attended by a mortality of 41 per cent. Of 119 patients operated on before 1877, only 19.6 per cent. died. Of 250 cases reported by Kocher, the mortality was only 2.4 per cent., including all cases; or, excluding those of malignant disease and five of exophthalmic goitre, less than one per cent.

Myxœdema; Cachexia Thyreo-priva.—The danger of total thyroidectomy depends on the removal of all thyroid gland tissue, and the consequent induction of a condition known as *myxœdema operativa*, or *cachexia strumipriva*. The first contribution to this subject was made by Reverdin, of Geneva, in September, 1882, and about the same time Kocher noticed the development of this condition in patients whom he had subjected to total extirpation of the thryoid gland. Thyroid cachexia does not, however, develop in every case after thyroidectomy. Among 34 patients operated on by Kocher, the cachexia existed in a more or less marked degree in 24. According to Trombetta, only twenty-seven per cent. of thyroidectomies are followed by myxœdema. It is probable that in many cases in which the patients remain well after the operation, portions of gland tissue with normal functions have not been removed, or that accessory glands have assumed the physiological work of the gland proper. It is also worthy of note that most of the cases hitherto reported have come from Switzerland, whereas the patients operated upon by Billroth, Credé, Wölffler, and others, have for the most part remained well. It is possible, therefore, that a primary climatological influence may weigh as an etiological factor in the development of operative myxœdema. The report to the Clinical Society of London contains 277 cases of total thyroidectomy, in 22 of which the goitre returned, or development of accessory glands ensued. These cases remained free from symptoms. In 186 there were no traces of cachexia, although the goitre did not recur and compensatory enlargements were not found. Only in 96 cases were the symptoms of myxœdema more or less pronounced. In only one-per-cent. of partial thyroidectomies has the cachexia developed in consequence of a reflex atrophy of the remaining portion of the gland.

Ordinarily insidious in its beginning, the disease progresses until in from three to six months after the operation the cachectic condition is well established. While on the one hand the condition may develop with foudroyant manifestations immediately after the effects of the operation have passed off, on the other hand symptoms may be delayed

[1] Annals of Surgery, vol. xii., p. 161.

for a year or more. The condition is usually ushered in with a sense of weariness and of weight in the extremities, accompanied by more or less pain. Fibrillary muscular contractions, diminished precision, particularly of the more delicate movements, and impaired muscular power follow. Cardiac palpitation, difficulty of speech, loss of memory, and gradual depreciation of the intellect supervene in rapid succession. The cachectic condition is made manifest by intense pallor of the skin, accompanied by a pseudo-œdema affecting chiefly the face and hands. The skin is hard and dry. The function of the sweat glands may be entirely lost. The integument and superficial fascia become doughy, but there is no pitting on pressure as in true œdema. Myxœdema may likewise affect the palpebral and oral mucous membranes. The entire facial expression is changed as the disease progresses, until in extreme cases the physiognomy of idiocy is established. Epilepsy is occasionally developed, as is a condition of tetany which may speedily cause death. When the disease occurs in the young, there is a marked arrest of physical growth.

Myxœdema operativa, like its analogue idiopathic myxœdema, first described by Sir William Gull in 1873, runs a slow but progressive course. It may last from six to twenty years, and usually ends in death from some intercurrent affection. According to Kocher there is never any amelioration of the symptoms, when the disease is once established, but on the other hand Reverdin and Julliard have seen improvement and almost complete recovery ensue after an unquestioned cachexia had existed for many months. According to the investigation of 109 cases by the Myxœdema Committee of the Clinical Society of London, improvement occurs in about fifty per cent. One condition is common to all cases, namely, some destructive change of the thyroid gland, commonly consisting in the substitution of a delicate fibrillar tissue for its normal granular structure.

Observation of the disastrous results of total thyroidectomy and the investigation of idiopathic myxœdema have thus established the importance to health and growth of the thyroid gland. Physiological investigations by Schiff and von Eiselsberg, Wagner, Zesas, and Horsley, have definitively elevated the gland to a position of almost vital importance. What its precise function is, has not yet been determined. It would be out of place here to consider the many theories advanced. It is probable, however, that the gland prevents the accumulation of mucin in the system, not by a process of elimination, but by converting it into a harmless and probably useful substance. Enough has been established to make total thyroidectomy an operation to be performed only for malignant disease. Fortunately the therapy of myxœdema is far from hopeless. By successfully grafting portions of the excised thyroid gland into the peritoneum, von Eiselsberg saved two animals from myxœdema. Horsley and Collins, with moderate success, have transplanted sheeps' thyroid into human subjects. In 1891 G. R. Murray suggested the use of the thyroid extract by hypodermic injection. Many methods of administering the gland have since been tried by numerous writers, with almost marvellous results. The improvement is constant whatever the method of administration adopted, and speedily follows the beginning of the treatment. The best, because the most convenient, method is by the administration of a dry extract of the gland.

Operations for Goitre.—The operations to be considered are: (1) Partial extirpation of one lobe. (2) Intra-capsular enucleation. (3) Evacuation, or *évidement*, of Kocher. (4) Resection or amputation. (5) Ligation of the afferent arteries.

(1) *Extirpation.*—An ample incision is made either in the median line or along the inner border of the sterno-cleido-mastoid muscle, from the jugulum to the cricoid cartilage. The median incision may be curved outward (Kocher's method) for a varying distance over the border of the muscle. Superficial veins are avoided or divided between double ligatures. The deep fascia is next divided along the entire length of the external incision, and all muscles presenting over the face of the tumor are treated likewise. The sterno-hyoid, sterno-thyroid, omo-hyoid and sterno-mastoid must be held aside or divided. The superior thyroid artery as well as the veins in its immediate proximity are now sought for, isolated, and ligated. Next the division of the external capsule of the gland is proceeded with, and by blunt dissection this is stripped off the tumor and the latter is turned out of its bed, working from above downward. Gradually the position of the inferior thyroid artery is approached; it is to be isolated with its accompanying vein, and ligated as far outside of the tumor as possible, taking care in this manner not to include the recurrent laryngeal nerve. By blunt dissection the isthmus is now lifted from the trachea and included in two or more ligatures, when the tumor, *en masse*, is removed; it is perhaps better to cut through the isthmus and secure separately any bleeding vessels (Tillmann).

(2) *Enucleation (Socin's Operation).*—This owes its origin to the nodular character of many goitres, and to the fact that these nodules have a distinct though often very thin capsule surrounding them. The operation is begun by laying bare the tumor just as in extirpation. Instead of ligating the vessels, however, the individual nodules are now sought out. It is important in doing this to thoroughly recognize the capsule of the nodule; in the case of those which are superficially situated this is easy, but it is often necessary to cut through a layer of vascular parenchyma before the capsule is reached. The capsule, having been recognized by its grayish tint, is carefully cut through and the nodule shelled out. The hemorrhage during this operation is not great unless a thick layer of gland tissue be cut through in order to reach the nodule, and even in this case it is not usually excessive. The chief merit of this operation lies, of course, in its avoiding the necessity of ligating the thyroid arteries and veins, and in its placing the recurrent laryngeal nerve beyond jeopardy.

(3) *Évidement or Evacuation (Kocher's Method).*—This differs from enucleation, as just described, principally in being more rapid of execution. Instead of carefully isolating the capsule of the nodule, it is at once bisected with the knife, when the two halves are emptied with finger and scoop, or curette. It is, like enucleation, indicated only in cases of nodular goitre.

(4) *Resection or Amputation.*—It is evident that any quantity of thyroid tissue may be cut away by the use of ligatures *en masse*, or, as was formerly practised, by the thermo-cautery. It was really on this principle that Mikulicz developed into a method the plan of so-called "resection," although it is said to have previously been done by others.

It is claimed that this method precludes injury to the recurrent laryngeal nerve, but this has been denied.

The incision may be in the median line, with an angular extension upward and outward at the level of the hyoid bone, or it may be along the anterior border of the sterno-mastoid, as in extirpation. The surface of the gland is then bared as in the operations already described, and the affected lobe is freed by blunt dissection. The superior thyroid artery and veins are next ligated, as well as any others which may enter the gland above its inferior cornu. The isthmus is then divided as in extirpation. The only portion of the lobe now adherent is the lower cornu, with the inferior thyroid artery and recurrent laryngeal nerve. This portion is ligated in several divisions and cut off, leaving a "piece the size of a horse chestnut." By making a second angular extension of the incision toward the other side, giving the whole incision a Y-form, the other lobe of the gland may be proceeded with in the same manner as the first.

(5) *Ligation of the Afferent Arteries of the Thyroid.*—This is perhaps technically the most difficult operation practised upon the thyroid gland, and it is not very frequently employed. Its performance as a therapeutic measure has been justified by Wölffler after experiments on dogs. He has shown that where all the afferent arteries of one lobe of the gland are ligated, there follows a necrobiosis with consequent absorption, not accompanied by any more rapid death of tissue. Recurrence is however possible after this operation by the free development of collateral anastomoses.

The operation is begun by tying the superior thyroids. The superior thyroid artery is found in the superior carotid triangle, and the operation is practically the same as for exposing the external carotid at the place of election. The incision is made over the anterior border of the sterno-mastoid with its centre opposite the upper border of the thyroid cartilage. The artery is found immediately after dividing the platysma. When the thyroid is greatly enlarged upward the relation of the parts is somewhat changed, so that the artery should then be sought at the anterior border of the omohyoid muscle. Care should be taken not to include the superior laryngeal nerve, which closely accompanies the artery.

To tie the inferior thyroid, an incision is made over the anterior border of the sterno-mastoid on a level with the cricoid cartilage, and is extended to the clavicle. The sterno-mastoid is drawn outward, as are the carotid and accompanying vein when exposed. The inferior thyroid will be found as it passes from behind the carotid artery, slightly below the transverse process of the sixth cervical vertebra, which can be felt through the wound. By placing the ligature close to the carotid it will be easier to avoid the recurrent nerve. In very large goitres it may be advisable to seek the artery by an incision along the outer border of the sterno-mastoid. Drobink and Rydygier have successfully operated many times after this method.

Résumé of the Different Operations.—That combinations of two or more of these operations, and variations of all of them, should be made by various operators might be expected; thus Kocher has described an operation as "resections-enucleation," intended as an improvement upon the resection of Mikulicz. Hahn begins by ligature of

the superior thyroid arteries and compression (with forceps) of the inferior; he then makes a bloodless *évidement*. Wolff, on the other hand, adopts no preliminary ligation whatever, relying upon "methodical compression" for control of the hemorrhage.

The *indications* for the different procedures will be briefly mentioned. Generally speaking, it may be said that, where it is possible, *enucleation* is the best operation, as best avoiding injury to important organs of the neck and to whatever of sound thyroid tissue there may remain.

Partial extirpation is indicated when there is diffuse hypertrophy of the gland, especially if there be left some sound tissue; also when there exist a very large number of small nodes.

Enucleation is the operation to be chosen when the goitre is cystic, and in the case of large nodes in simple goitres.

Évidement may be used for any nodular goitre when dispatch is of importance; also in "struma nodosa" when the nodes are soft and yielding.

Resection may be employed when it is impossible to do one of the previous operations as planned, when the nature of the tumor is uncertain, or when in a case of diffuse hypertrophy there is no sound tissue to be left, and especially when it is desired to operate upon both sides without making the extirpation total.

Ligation of the arteries is an operation which by itself is seldom called for. The principal indication for it would be the presence of a "struma vasculosa."

Since the introduction of more rapid and safer methods, large cystic goitres are now rarely treated by the older procedures of tapping, injection of medicinal fluids, the seton, incision, or drainage. For these goitres enucleation may be said to be the only proper operation. Ordinarily the cyst is surrounded by a very dense capsule, which deprives its enucleation of technical difficulties. The hemorrhage, which is usually slight, comes from the divided overlying normal gland tissue. As in the removal of cysts from other parts, every effort should be made for its enucleation as an unbroken mass. When before the operation injections of iodine, oft repeated, have caused adhesions to form about the sac, this may be impossible. Should rupture occur under these circumstances, the sac must be split in its length and carefully dissected away.

Goitres once removed do not ordinarily recur. Nevertheless, after operations short of total extirpation, recurrence has been noticed in somewhat less than ten per cent. of cases, either on the side operated upon or in the opposite lobe. It is interesting to know, too, that operations on one lobe of a diseased thyroid have often been followed by diminution in size of the remaining half of the gland. Simple division of the isthmus, in two cases reported by Sydney Jones,[1] were followed by atrophy and permanent cure.

Malignant Goitre.—Carcinoma and sarcoma occasionally develop in the thyroid gland. As a rule, malignant disease is grafted in an already existing goitre, or invades the gland from some neighboring organ—the œsophagus or larynx. Primary carcinomata of the gland are very rare, occur chiefly late in life, and considerably oftener in men than in women. Primary carcinoma usually presents the cylindri-

[1] Lancet, 1884, vol. ii., p. 367.

cal type of epithelial cell; secondary carcinoma presents the flat cell of œsophageal or laryngeal epithelioma. Of the sarcomata all varieties have been found in the thyroid.

The chief clinical characteristics of malignant disease of the thyroid gland are rapidity of growth and extensiveness of adhesions, impediment to respiration and deglutition often out of proportion to the size of the tumor, early involvement of the lymphatic glands of the neck and mediastinum, and marked tendency toward metastatic dissemination. In very many cases of successful extirpation of malignant goitre, unsuspected deposits have been subsequently found in the lungs, liver, or spleen. The treatment of malignant goitre is most unsatisfactory. To relieve urgent dyspnœa it may be imperative to perform tracheotomy, an operation which under these circumstances is singularly fatal. Langenbeck reported seventeen cases without a recovery. In total extirpation of the malignant growth lies the only hope of the patient.

Exophthalmic Goitre.—In 1869 Eulenburg called attention to the development of the symptoms of Graves's disease as a consequence of goitrous growths. Tachycardia, huskiness of voice, and muscular tremor may be considered a result of mechanical irritation of the sympathetic and recurrent nerve filaments. Since Tillaux's first extirpation of the thyroid for Graves's disease in 1884, the term surgical Graves's disease, as distinguished from the idiopathic form of exophthalmic goitre, has properly found acceptance.

In all forms of Graves's disease surgical treatment has been resorted to. Enucleation, partial extirpation, and resection have been practised in many cases without a death from the operation. According to the recent tabulation of Freiberg,[1] the symptoms were relieved by operative treatment of the surgical goitre in 9 out of 10 cases. Of 11 cases of true morbus Basedowii, 7 were reported cured by operation. In 9 of the cases, total or partial extirpation of the tumor was practised. The fact that partial extirpation of the goitrous gland in true and surgical Graves's disease is practically devoid of danger, has been established. Not so, however, the certain curability of the disease by operation. That many patients have been greatly improved cannot be questioned. In what proportion permanent and absolute relief has been given, cannot as yet be determined, since many cases have been reported within from only six weeks to six months of the operation. Only in a few cases, as in one of Riedel's (three years), has sufficient time elapsed since the operation to allow the result obtained to be designated as perfect and permanent.

[1] Medical News, 1893, p. 225.

INJURIES AND DISEASES OF THE AIR-PASSAGES AND OF THE ŒSOPHAGUS.

BY

W. C. GLASGOW, M.D.,

OF ST. LOUIS.

ŒDEMA OF THE LARYNX.

ŒDEMA of the larynx occurs in the form of: Acute Inflammatory Œdema; Chronic Inflammatory Œdema; Simple Serous Œdema; Angeio-Neurotic Œdema; Solid, or Lymphoid Œdema.

ACUTE INFLAMMATORY ŒDEMA.—This occurs as a result of an acute phlegmonous laryngitis, or, in a limited number of cases, of a catarrhal inflammation of the larynx. In these cases the œdema may be the most prominent feature and the essential factor in causing the gravity of the lesion.

Pathology.—Inflammatory œdema of the larynx consists essentially in an infiltration of the submucous areolar tissue with a serous, a sero-purulent, or a sanguineous fluid. It is found chiefly in those parts of the larynx where the attachment of the mucous membrane to the deeper structures is loose, thus affording sufficient space for the fluid to accumulate. This condition is specially marked in the ary-epiglottidean fold, the ventricular bands, the laryngeal surface of the epiglottis, and the posterior surface of the larynx. The mucous membrane of the vocal cords is to a great extent closely attached to its underlying tissue, but toward its edge it is more loosely connected (Fournier), and this part may be the site of œdema.

Œdema of the infraglottic region is not infrequent. When it occurs in connection with acute phlegmonous laryngitis it is associated with intense inflammation of the mucous membrane, and with hypersecretion of the muciparous glands. The mucous membrane becomes swollen and œdematous, and shows a pallid appearance. The parts involved stand out in marked relief, in contrast with the surrounding membrane. When the ary-epiglottidean folds are involved the œdema is usually bilateral, and the swollen folds appear as two grayish pyriform swellings. When the œdema is great it may largely occlude the glottis and produce more or less dyspnœa. In œdema of the ventricular bands the glottis is greatly constricted. The vocal cords are completely covered

by the bilateral swelling, and an almost complete closure of the glottis may occur. In infraglottic œdema the mucous membrane of the upper part of the trachea appears as two swollen tumors, largely blocking up the lumen of the trachea, and producing more or less dyspnœa, according to the amount of the tumefaction.

In œdema of the epiglottis this part assumes a rounded, swollen appearance. The natural contours of the epiglottis are lost, and it appears as a grayish swollen tumor. When the œdema is excessive it may largely close the larynx, and if this occurs in conjunction with œdema of the ary-epiglottidean folds, respiration may be almost entirely prevented.

Etiology.—Acute inflammatory œdema occurring in phlegmonous laryngitis must be considered in connection with the primary disease. Like other diseases of the air-tract the most frequent cause is exposure to humid cold and the vicissitudes of the weather. A weakened condition of the system is an undoubted factor in favoring the development of the disease. It occurs rarely as a primary condition of the larynx; more frequently it is consecutive to a phlegmonous inflammation of the pharynx. Occasionally it is seen as a secondary affection in a subacute inflammation of the larynx, due to tuberculosis, syphilis, or cancer, but in these diseases the chronic form of the affection is more common. It has occurred as a complication in erysipelas, small-pox, and typhoid fever. Occasionally it results from traumatism, either by a foreign body or by some external penetrating wound. The swallowing of caustic fluids and the inhalation of irritating vapors have been known to produce it.

Chronic Inflammatory Œdema.—Chronic inflammatory œdema is seen most frequently in connection with diseases of the larynx which have a constitutional origin. Laryngeal phthisis, tuberculosis, and syphilis are most frequently the causes, and it adds largely to the distress and gravity of these affections. It also occurs in connection with diseases of the cartilaginous articulations, especially in the crico-arytenoid joint. Its extent rarely is as great as that of acute œdema, and is frequently limited to the tissues about the affected joint. It may arise as a primary condition, or may be connected with necrosis or caries of the cartilage. The œdema in these cases is caused by a sero-purulent infiltration of the tissue.

Simple Serous Œdema.—A simple serous œdema, or œdema in which the mucous membrane and connective tissue are infiltrated with pure serum, is always secondary to conditions which interfere with the venous circulation. It is found in all those conditions in which dropsical effusions occur in different parts of the body. It has been observed in acute and chronic Bright's disease, in heart disease as a result of weakened or dilated right ventricle, and also in cases in which pressure is exerted on the laryngeal, thyroid, or innominate veins, or on the descending cava. De Bary (Gottstein) notes a case of scarlet fever complicated with nephritis, and B. Frankel cites one in which laryngeal dropsy was the only evidence of effusion. McKenzie considers it very rare in Bright's disease, as, after having examined two hundred cases, œdema of the larynx was not found in a single instance.

ANGEIO-NEUROTIC ŒDEMA.—Angeio-neurotic œdema may be described as a circumscribed œdema, due to a vaso-motor neurosis. There is no appearance of inflammation, and in the acute form the œdema is caused by an infiltration of the tissues with pure serum. In the chronic form the infiltration seems to be due to the exudation of the cellular elements of the blood. The swollen part gives a hard brawny feel to the touch; it does not pit on pressure, and the line of demarcation between it and the healthy tissue is distinctly marked. The tendency to this form of œdema may continue for years. The swelling may continue for weeks, but then subsiding, it again recurs at irregular intervals. Quincke [1] has fully described it, as it appears on the skin in circumscribed œdematous swellings, and it has been further noticed by Ruhl,[2] Strubling,[3] Gottstein,[4] and Osler.[5]

On the skin it appears as a circumscribed swelling in various parts of the body, and it is frequently accompanied by symptoms of intestinal disturbance, such as vomiting, colic, and diarrhœa. Strubling has drawn attention to its occurrence in the mucous membrane of the upper air-passages. He claims to have seen it after exposure, or the ingestion of irritating substances, and from causes which have hitherto not been explained. It involves the mucous membrane of the palate, especially the palatine arches, and thence extends occasionally to the larynx. In acute cases, the parts affected have the transparent swollen appearance of a serous œdema. It appears suddenly, continues for a few hours and disappears as rapidly. In its chronic form, the tissues are densely infiltrated, resembling more a solid than a serous œdema. In some cases it has been noted that its disappearance from the throat has been followed by œdema of the skin of the face, and of the thorax. Strubling claims to have seen œdema of the larynx that followed a similar condition of the skin. The symptoms vary with the part affected. When in the upper part of the pharynx there is a feeling of fulness. When the larynx is involved there also appear the signs of laryngeal obstruction. There is no pain, and no febrile symptoms have been noticed. Cases have been noted in which the condition has proved fatal in a few hours. Strubling believes that angeio-neurotic œdema is dependent on an irritation of the mucous membrane, followed by dilatation of the blood-vessels with a transudation of serum.

Ruhl considers angeio-neurotic œdema to be due to some disturbance of the vaso-motor system having a central origin. In support of this view he cites the sudden occurrence of œdema of the skin, with disturbance of the intestinal canal and the general symptoms of drowsiness and oppression; also the frequent and sudden change of the site of the swelling, and the fact that it has been known to disappear through psychical influences.

I believe that the œdema of the fauces and larynx which has been seen to follow the use of certain drugs, notably iodide of potassium, may be classed as an angeio-neurotic œdema. It may appear as the only symptom of iodism, and it may be produced by the smallest doses.

[1] Monatshefte für practische Dermatologie, 1882.
[2] London Medical Record, December, 1887.
[3] Monatschrift für Ohrenheilkunde, No. 10, 1886.
[4] Die Krankheiten des Kehlkopfs.
[5] American Journal of the Medical Sciences, April, 1888.

Fournier relates four cases in which the dyspnœa became so great that the patients were only saved by a prompt performance of tracheotomy, and two others in which death occurred owing to delay in resorting to the operation. Groenow[1] relates two cases in which œdema of the larynx was caused by the same drug. In one case, after a succession of trials, tolerance was established, but in the other even minute doses continued to produce the œdema. I have seen a case of acute angeio-neurotic œdema arising from the use of quinine:—

Mrs. J. T., a lady from Texas, was given, for general debility, teaspoonful doses of an elixir of iron, quinine, and strychnine. One-half hour after taking it she experienced a feeling of swelling in the throat, accompanied by a sense of suffocation, with stridulous breathing, which was most distressing. When I saw her, two hours subsequently, she was partially relieved, the stridor had disappeared, and only a sense of fulness remained. On inspection, the pillars of the left side of the palate presented the appearance of an elongated bag of water, swollen, and seeming almost translucent. The right side of the pharynx was normal. The epiglottis was œdematous, as well as the posterior part of the larynx, but in a less degree. The swelling had evidently largely subsided, and in three hours had entirely disappeared. She said that in the preceding year her physician in Texas had given her a dose of quinine for malarial fever, and that she had then had a similar attack.

The following is a case illustrative of the chronic form of œdema:—

Miss S. has for five years been troubled with a recurrent swelling of the upper lip, which caused a most uncomfortable sensation and interfered with speech. I saw her first in 1894, when she complained of difficulty in breathing. The upper lip was at this time greatly swollen, the tumefaction involving the skin and a limited portion of the mucous membrane. The palate was rigid and infiltrated. The epiglottis was swollen, especially on its under surface, and it largely obstructed the laryngeal orifice. Two distinct swellings of a pyriform shape were seen over the arytenoid cartilages, closely resembling the pyriform swellings of laryngeal phthisis. The œdema subsided, but recurred several times after exposure and fatigue.

Solid or Septic Œdema of the Larynx; Influenza Œdema.—This condition was first described by myself in notes read before the Medico-Chirurgical Society of St. Louis in 1886, and was fully described in a paper read before the American Laryngological Society at its eleventh annual congress, in 1889 (Septic Œdema of the Air-Passages). My observations were confirmed in a paper read by Dr. J. Solis Cohen at the succeeding congress in 1891 (The Symptoms and the Pathological Changes in the Upper Air-Passages in Influenza), and the condition has also been observed by Carl Seiler, De Lostalat, and Bavacki.

Septic or solid œdema is closely connected with the epidemic of influenza or grippe which has been prevailing during the past years. The cases seen from the year 1886 to the year 1890 may strictly be regarded as sporadic cases, and may be considered as illustrating one of the protean forms of this disease. Septic œdema, or lymphoid œdema as it has been called by J. Solis Cohen, is the result of an infiltration of the mucous membrane and connective tissue of the air-tract by a cellular material, with a stasis of the venous and lymphatic systems. The local condition of the upper air-passages is secondary to and char-

[1] The Practitioner, June, 1890.

acteristic of the morbid state of the blood existing in influenza, and is similar to the condition found in the mucous membrane of the bronchi and in the walls of the air-vesicles.

This solid œdema may involve any part of the air-tract. It is seen in the nasal, post-nasal, pharyngeal, laryngeal, and bronchial mucous membrane, and in the walls of the air-vesicles. It is most frequent in the palate and in the lateral walls of the pharynx. More rarely it involves the larynx, and then constitutes a grave form of disease. To the eye the membrane has a swollen, œdematous appearance, and is paler than the normal mucous membrane. The veins are enlarged and may be visible. The membrane appears dry and pale, although in many cases a viscid secretion is present, and when artificial light is thrown upon it this may present a sparkling appearance. To the touch it gives a solid feeling, with an entire want of its normal elasticity, and it does not pit under pressure.

When the larynx is involved we may find the mucous membrane of the ventricular bands, the true cords, the epiglottis, and the posterior surface of the larynx affected. More frequently we find the œdema limited to one of these parts, the other portions remaining normal. When the true cords are involved we find them, on inspection with the laryngeal mirror, swollen, pale, and glistening. This swelling is especially noticeable at the edges of the cords.

When the ventricular bands are affected the œdema is generally bilateral. The bands are symmetrically swollen, and may cover the true cords to such a degree as to produce a most complete stenosis of the larynx.

Œdema of the epiglottis changes this organ into a symmetrically swollen tumor. In small children it may be so much enlarged as to almost entirely close the glottis. With this swelling there is no sign of inflammation, and secretion may be entirely absent. In many cases, in addition to the swelling, we notice a paresis of the true cords due to imperfect action of the adductors.

The *symptoms* of septic œdema of the larynx depend upon the part involved. When the true cords are the site of the œdema there is an impairment of the voice, which is especially noticeable in singing. In many cases the voice fails completely and the greatest effort does not suffice to produce a tone. This condition usually comes on suddenly. This loss of the singing voice may be present, although the voice of ordinary conversation may appear normal. When the ventricular bands are affected the symptoms will depend upon the amount of tumefaction. If slight there may be no special symptoms. When great, however, the larynx may be almost completely closed. This condition is especially a dangerous one, for there is always a tendency to spasm of the glottis which may be quickly fatal. A minor œdema or swelling of the ventricular bands may cause a certain degree of hoarseness or huskiness of the voice. Œdema of the epiglottis rarely causes symptoms in the adult. In infants it produces the symptoms of spasmodic croup. In œdema of the ventricular bands and of the epiglottis in children, there may be marked stridor in both inspiration and expiration. This is persistent, and at times becomes greatly intensified when the element of spasm is added to the obstructive lesion.

The constitutional symptoms of septic œdema are those of influenza.

There are more or less prostration, languor, and drowsiness. A slight degree of fever may be present at the beginning, and there may be varied and fleeting pains in different parts of the body, or any of the various symptoms seen in this disease. The condition usually arises suddenly and in some cases subsides very rapidly, but in others may continue for months.

Diagnosis.—The diagnosis of septic œdema must be made with the laryngoscope. It may be confounded with a catarrhal inflammation of the larynx. The bilateral character of the swelling and the absence of all signs of inflammation will be important factors. In children, when laryngoscopic examination is not possible, the differential diagnosis from catarrhal or membranous croup will be difficult. The absence of the general symptoms of membranous croup and the rapid increase of the laryngeal obstruction will aid the diagnosis. The intermissions of the laryngeal stridor, both on inspiration and expiration, and the remissions of catarrhal croup, are entirely foreign to this disease. The laryngoscope will in most cases distinguish between these conditions, and this may be used in the youngest infant.

Prognosis.—The prognosis of solid œdema is usually favorable under proper treatment. In some cases, however, when the spasmodic element is added, it causes grave anxiety. The spasm of the glottis occurs at unexpected times and from unknown causes, and unless prompt measures are taken it may prove fatal.

Treatment of Œdema of the Larynx.—The treatment of œdema of the larynx will depend upon the cause. In *acute inflammatory œdema* scarification of the part affected will be the first indication. This may be done with the laryngeal knife, or even in an emergency with a long curved bistoury. The incision will promptly allow the fluid to escape, and will thus reduce the tumefaction. Insufflation of tannin has been highly recommended, but the knife will accomplish the desired effect much more satisfactorily and properly. General measures to promote the action of the skin and the secretions will be of benefit. The application of hot cataplasms to the neck, and the use of ice internally, will aid in reducing the swelling. After the parts have been punctured the use of hot gargles and drinks will promote the discharge of the fluid. In some cases the application of an ice bag, or of a Leiter coil with iced water, has been of benefit in the early stages. All of these measures aid in allaying the primary inflammatory condition, but they cannot take the place of scarification.

In *chronic inflammatory œdema* the treatment must be largely directed to the primary disease. If this can be relieved, the œdema will disappear by the aid of such simple means as the use of ice and the insufflation of tannin. Occasionally, however, when the swelling is great, scarification will be necessary, as occurs sometimes in laryngeal phthisis, when great tumefaction of the part may prevent the taking of food, not only through the obstruction but by the pressure causing pain. A few punctures with a lancet will often relieve the local condition, but when this fails tracheotomy will be the only resource.

In *simple serous œdema* attention must be given to the disease which causes the effusion. The action of the skin, the bowels, and the kidneys must be promptly and vigorously increased. Gottstein has

reported most favorably of the hypodermic use of pilocarpine in these cases. Scarification, although giving temporary relief, will not replace the measures needed to overcome the prevailing venous engorgement and obstruction.

Acute angeio-neurotic œdema usually subsides in a short time without the use of remedies, although the nervines will be theoretically indicated. When grave symptoms are present the use of the knife is imperative. In the *chronic* form, arsenic and the bromides are useful. I have obtained excellent results from the use of ichthyol, as recommended by Unna in urticaria and by Hardaway in this form of œdema. Morrow advises the use of pilocarpine.

The treatment of *solid septic œdema* will be the treatment of influenza. I have found in the benzoate of sodium in large doses (twenty grains every two hours for the adult), a most useful drug in promoting a reduction of the cellular infiltration. The spray, or local applications with a cotton pledget, of carbolized iodine in strong solution will reduce the swelling and give relief to the distressing dryness. When, however, the œdema remains in spite of these measures, and when it affects the ventricular bands in a marked degree, tracheotomy should be employed. The tendency of the œdema to sudden increase from atmospheric or unknown causes, and the great frequency with which it becomes associated with spasm of the glottis, render this condition exceedingly grave. Many cases of the laryngeal œdema of influenza might have been saved by opening the trachea as soon as the spasmodic element was added to the obstructive, or when the ventricular bands were so swollen as to close the respiratory portion of the glottis. This is especially the case with children. The condition is entirely different from that of spasmodic or membranous croup. In both of these diseases the great obstruction is from spasm of the glottis, which shows a remission at certain periods. In membranous croup temporary relief will come from expulsion of a portion of the membrane, but in solid œdema the ventricular bands and the vocal cords are solidly infiltrated and the obstruction continues without change. The persistence of this obstruction in the larynx eventually leads to a mechanical congestion of the lungs with resulting heart failure, through acute dilatation of the right ventricle. The longer the operation is postponed, the less chance will the patient have for recovery. I believe from experience that when this condition has been verified by a laryngoscopic examination, and the signs of laryngeal obstruction have been present in a marked degree for two hours, or when the spasmodic element has become evident, the trachea should be promptly opened. The tracheal tube must be worn until the œdema has entirely subsided, which may be for weeks or even longer. In a case known to myself the tube was worn by an adult for nine months before it could be removed.

Lymphoid Hypertrophy of the Vault of the Pharynx.

Meyer, of Copenhagen, in 1868, first drew attention to the existence of a mass of so-called adenoid tissue in the pharyngeal vault as a cause of disease. Since then it has been widely studied, and a series of phenomena producing more or less derangement of the general health, and

especially disturbance of the respiration, have been ascribed to its presence.

According to Luschka, adenoid tissue is always present in the vault of the pharynx. It is apparent at the earliest age, and has been said to be congenital. During childhood it has a tendency to hyperplasia and growth, so that at times it becomes a pathological tissue. Luschka describes it as extending across the vault of the pharynx, between the fossæ of Rosenmüller. The hypertrophied mass is found most frequently in the back and upper part of the vault. It may consist of simply a fringe-like mass projecting downward, located at the top of the vault of the pharynx, or it may fill the greater part with a hard, solid growth. Most commonly this mass is composed almost entirely of lymphoid tissue, with a minimum amount of connective tissue. In some cases, however, the connective tissue is more developed, and we find the mass presenting the dense, hard appearance of fibrous tissue. As a rule, however, the tumor is soft and friable, especially in young children. In adults I have seen a hard, smooth mass occupying the upper part of the vault which seemed to be formed of well-developed fibrous tissue.

The growth of lymphoid tissue assumes its greatest proportions during the years of childhood, and there is a notable tendency to retrogression or disappearance after the tenth year, and between the fifteenth and twentieth years. At least it is not found as a lymphoid growth, and in some cases, where the development of fibrous tissue is excessive, we find a disappearance of the lymphoid tissue, but the fibrous growth remains, and this may continue indefinitely.

In growths, however, in which the connective tissue is imperfectly developed, the whole mass may disappear between the tenth and the fifteenth year. The lymphoid growth in this respect repeats the history which we so often see in the faucial tonsil. In some individuals the disappearance of the adenoid tissue takes place sooner than in others. This subsidence of lymphoid hypertrophy has been called an atrophy, but I should rather consider it an absorption or retrogression.

Many causes have been assigned by writers for the development of this lymphoid hypertrophy. Some have claimed that it is due to improper sanitary surroundings, while others attribute it to malnutrition and imperfect assimilation. I cannot agree with either of these propositions. Most of the cases which have come under my observation have been in children whose surroundings from a hygienic point of view have been good, and whose general physique has been that of good health, save as it may have been modified by the mechanical obstruction of the growth itself. I would rather ascribe its occurrence simply to the tendency which is generally acknowledged to be present in childhood to growth and hyperplasia of lymphoid tissue. Usually this hypertrophy is not confined to the vault alone, but may in some cases be found involving the faucial tonsil to a greater or less degree. Although the constitutional condition known as struma develops a special tendency to hypertrophy of the lymphoid structures, still in the majority of these cases we fail to find the other and varied manifestations of this condition, and hence I cannot strictly connect the lymphoid hypertrophy with the strumous diathesis, but would rather ascribe it to the special tendency in the years of childhood to lymphoid hyperplasia,

aided by some form of local irritation which has been the inciting cause. This local irritation will be found in many of the diseases of childhood and infancy, notably in the exanthemata, and especially measles. It will also be found in certain conditions of the nasal mucous membrane, in which respiration is imperfectly performed through the nose, and in which a subacute catarrhal inflammation of the posterior naso-pharynx has resulted. It may be due likewise to such atmospheric conditions as would produce a naso-pharyngeal catarrh in the adult.

Symptoms.—The symptoms of lymphoid hypertrophy of the vault of the pharynx will depend upon the situation of the growth and its toleration by the individual; that is, upon whether it has or has not set up a series of secondary phenomena which produced certain symptoms. These may be described as nasal, post-nasal, or aural, and as disturbances of the respiratory act. To these must be added the secondary symptoms resulting from a long continuance of the hypertrophy, which produces impairment of the bodily vigor, growth, and nutrition. Reflex disturbances of the nervous system, especially those relating to the larynx, must in some cases be considered secondary symptoms of this lymphoid hypertrophy. The predominating *nasal* symptom is obstruction of the nares. The obstruction may be partial or complete, depending upon the extent of the growth in blocking up the posterior extremity of the nasal canal, and upon the amount of tumefaction of the nasal mucous membrane which may be the result of this obstruction. The imperfect ventilation of the nares in such cases tends to produce a hyperæmia of the whole length of the nasal canal, with an ultimate hyperplasia of the structures known as hypertrophies. The posterior obstruction may also produce a further obstruction in the anterior portion of the canal by the contraction or drawing in of the walls of the nose with each attempted inspiration. This, however, is not peculiar to hypertrophied growths, as it may be present in any case of partial occlusion of the posterior end of the nasal canal. A purulent discharge from the nostrils is frequently seen. This originates in the posterior nares and occurs either through the nose or into the naso-pharynx. The patients are usually of a strumous constitution and the discharge results from an acute inflammatory condition. Slight hemorrhages may occur. This is frequently seen at night, when the pillow may be found stained with blood spots. A special deformity of the nose arises in cases of long-continued obstruction. The sides of the nose become flattened and pinched. This, with a constantly open mouth and curvature of the upper lip, presents a picture of facial deformity which is pathognomonic of the disease. Mouth breathing is always the sequence of long-continued obstruction of the nasal passages. In cases where the amount of obstruction is small, this takes place mostly during sleep, the self-control of the child being sufficient to keep the mouth closed during the day, although the obstruction of the nasal passage is insufficient for respiration. In cases of great obstruction the mouth remains open and the respiration is performed entirely through it.

The *post-nasal* symptoms are chiefly the constant discharge of a muco-purulent secretion. Sometimes this exists in great quantities and and it is occasionally found mixed with blood. In older individuals complaint is sometimes made of a feeling of fulness in the upper part of

the throat, or a sense of irritation is experienced in the naso-pharynx. An annoying sensation of contraction in the posterior nares was experienced by a young adult; this seemed to be due to the presence of an elongated fibrous band extending along the summit of the pharyngeal vault.

In recent years aurists are holding these lymphoid growths of the pharynx responsible for a number of diseases and disturbances of the ear, notably chronic otitis media both simple and purulent. The exact relation between aural disease and the presence of lymphoid hypertrophy has been a matter of discussion, but the fact has been clearly established that a large number of children suffering with enlargement of the pharyngeal tonsil show a varying degree of deafness, notably the result of a chronic catarrh of the Eustachian tube, or middle ear. Some writers claim that the aural complication is the result of an impingement of the lymphoid tissue on the mouth of the Eustachian tube, preventing the proper ventilation of the aural cavity. In practice, however, we rarely, if ever, see the growth occluding the Eustachian orifice, and still, in many of these cases, aural disease is present. Others consider that the mere presence of the lymphoid hypertrophy in the vault interferes with the necessary renewal of air in the aural cavity, thus exciting aural disease, employing the same argument which is used to connect nasal hypertrophy with disease of the middle ear.

Still others believe that aural disease is the result of a simultaneous catarrhal inflammation of the two regions, or of an extension of inflammation from the naso-pharynx to the Eustachian tube and middle ear. It is a well-known fact that children with lymphoid hypertrophy of the nasal pharynx are especially prone to inflammation of the mucous membrane of this region. It is natural and in accordance with the history of catarrhal inflammation that the mucous membrane of the Eustachian tube should be involved through contiguity. A slight degree of deafness, with symptoms of Eustachian catarrh, may arise simply from a swelling of the mouth of the tube. In favor of this theory is the fact that deafness and the Eustachian symptoms are temporarily improved through simple treatment of the naso-pharyngeal space, with the necessary inflation of the tube, although the great body of the growth still remains. Chronic purulent catarrh of the middle ear may arise through great intensity of the inflammatory process, or in individuals specially prone to this form of inflammation.

In the production of voice tones, both in speaking and singing, the importance of a clear naso-pharynx has been fully established, and the presence of this lymphoid hypertrophy in the vault exercises a pronounced and disturbing effect. The resonating quality of the voice will be more or less impaired according to the extent of the growth, and, thus losing in a measure its tone, it will become dull and muffled. According to Loewenberg, in the speaking voice the resonating consonants N and M will be replaced by D and B. This marked effect can only occur, however, when the size of the growth entirely precludes the possibility of nasal respiration.

In recent years the presence of the pharyngeal tonsil has been made responsible for many of the laryngeal disturbances of childhood. Laryngismus stridulus and false croup are claimed by many writers to

be due to this cause, and, indeed, Lennox Browne makes the assertion that almost all, if not all, subjects of laryngismus stridulus or false croup will be found to be mouth-breathers. I cannot agree to this statement, for although many reflex neuroses depend upon some point of irritation in the upper air-passages, many children with enlargement of the pharyngeal tonsil show no tendency to reflex disturbance in the larynx.

On the other hand, when a child is forced to breathe through its mouth through an obstruction of the nostrils or posterior nasal space, we should naturally expect that pathological conditions of the lower throat would result. The respired air is no longer filtered and warmed as when it passes through the natural respiratory passage, and the unnatural efforts of the child in mouth breathing will have a tendency to develop any neurosal tendency which may exist. The presence of a neurosal tendency or habit will be a necessary factor in producing the disturbance, and when this exists, the lymphoid hypertrophy of the pharyngeal tonsil, especially when it is the subject of catarrhal inflammation or hyperæmia and thus presents a sensitive surface, may well be the provoking cause of the laryngeal neurosis. The same explanation may be given of those cases of asthma which have been ascribed to this pathological condition of the naso-pharynx.

That the obstruction of the nostrils, especially when it is great and continued for a long time, has a most unfavorable effect on the development and growth of the body, has been fully established. It is especially in the earlier years that we find evil resulting from this continuance. In infants, mouth breathing is an unnatural, persistent effort. An insufficient amount of air enters the lungs, and they are not distended to their full capacity. The bony framework of the chest suffers through inaction, and there is a constant tendency to thoracic deformity. The antero-posterior diameter is flattened, and in some cases there is sinking in of the sternum. With an insufficient amount of air respired, the general growth and development must suffer, and we find many of the general symptoms referable to malnutrition, and especially to the tendency to develop any neurotic habit which may have been inherited.

Diagnosis.—The diagnosis of lymphoid hypertrophy of the pharyngeal vault will be easy when the development of the growth occludes the nasal passages. The open mouth and facial deformity indicate the disease. When the amount of lymphoid tissue is not sufficient to entirely close the nasal passages the diagnosis is less easy, and the condition must be differentiated from obstruction of both the anterior and the posterior nares. Various methods have been given by which this can be accomplished. A rhinoscopical examination, if possible, will at once settle the diagnosis. Anterior examination of the nostrils is not so satisfactory, as frequently hyperæmia of the membrane and hypertrophy are concomitant conditions. The application of cocaine will reduce the hyperæmia, but has no effect upon the hypertrophy. It is proposed by some to examine the posterior pharynx by means of the finger. A soft earth-worm feeling is given to the finger when soft growths are present, and the hard, tumor-like growths can be at once detected. If this was always possible or advisable, no other measures, for the purpose of diagnosis, would be necessary. Any one, however, who has had a short, thick finger introduced into the mouth and through the

pharyngo-nasal space has found it a disagreeable and painful procedure. With larger children it may readily be done, but with younger children it should be avoided if possible. The terror and intense nervous disturbance of the child thus produced render the employment of further remedial measures most unsatisfactory. I believe that we have a measure which will largely replace the use of the finger in small children, and which will give almost as satisfactory results. In young children the hypertrophied tissue is almost always of soft consistence, and through their fulness the blood-vessels bleed readily when touched, while bleeding from the normal membrane will be the exception. A light probe wrapped with cotton can easily be introduced into the naso-pharynx of the child, and the different parts of the vault can be lightly rubbed. If the soft growths are present the cotton will be found stained with blood, and this, in my opinion, will justify the diagnosis. This may be an unpleasant procedure, but it does not produce the intense nervous shock which follows the introduction of the finger. In some cases the probe may be passed through the nostril into the naso-pharynx. The use of the spray or the douche through the nostril often fails to establish the diagnosis. It is stated that if the naso-pharynx is blocked the spray or fluid will fail to return through the opposite nostril, as it would in health. This is true; but the same result will be obtained in cases of posterior hypertrophies, although naso-pharyngeal hypertrophy may be absent.

Treatment.—In the treatment of lymphoid hypertrophy a certain difference of opinion will be found to exist, even among those who have had large experience. Some assert that whenever the presence of the hypertrophy can be verified it should be totally eradicated. Others, believing that the presence of the lymphoid tissue in the naso-pharynx is physiological, and that it is designed for some purpose, although its purpose has not so far been satisfactorily explained, contend that even if hypertrophied it should not be interfered with, but should be left to the absorption which Nature will accomplish in time, unless, through its size, it produces symptoms and disturbances which may be injurious to other organs, or may impair the growth and development of the body.

Under the latter circumstances the hypertrophy must be reduced or removed by surgical measures. The simplest operation is to tear the growth with the finger-nail, a plan which is only applicable to soft growths. I do not believe that the whole mass need be removed. I have found that when a soft growth has been well rubbed with the finger-nail, the crushing and the resulting hemorrhage bring about a process of absorption which removes the obstruction.

Instead of the finger I have used a stiff probe, to which a piece of sponge or pledget of cotton has been firmly attached. With this the naso-pharynx can be well rubbed and the growth broken down. It is much more agreeable than the finger, and equally effective. In some cases the probe may be introduced through the nostril, but in the majority it must be passed through the mouth. When the growth is firm and dense it must be removed by the post-nasal forceps, the post-nasal curette, or the wire snare. The forceps must be so shaped that it may be used in the naso-pharynx without injuring the posterior surface of the palate. The forceps of Juratz has given the best results

in my hands. The curette, preferably that of Gottstein, will accomplish a great deal. In using both the forceps and the curette care should be taken not to injure the Eustachian orifice.

The wire snare may be used in a certain number of cases when entrance can be obtained through the nostrils, and occasionally it may be used to advantage when introduced behind the palate. When it is possible to use the wire snare, and the growth is hard, I believe this to be the preferable means of removal, especially with large children, who can aid the operator. The snare cuts quickly through the growth, and the operation is rapidly performed. The question of the use of chloroform or ether is a debatable one, but the weight of opinion is in favor of their employment, especially with small children. With a state of partial anæsthesia, the operation can be more thoroughly and satisfactorily performed. In older children, especially if they have courage, anæsthesia may be dispensed with to their advantage.

RETRO-PHARYNGEAL ABSCESS.

An inflammatory swelling, generally in the posterior surface of the pharynx, is known by the name of *retro-pharyngeal abscess*. The inflammatory process involves the underlying connective tissue with the lymphatic glands, and usually tends to suppuration. The pus may collect in a circumscribed sac, or it may burrow downward in the line of connective tissue to the posterior mediastinum, perforating the trachea, œsophagus, or pleural cavity. In a case of my own the pus burrowed into the subcutaneous cellular tissue and perforated the skin, forming a fistula near the cricoid cartilage. It was formerly said that retro-pharyngeal abscess was most frequently due to caries of the vertebræ, but later and more extensive observation has proved that this view must be modified. A large number of cases result from caries of the vertebræ, but others are due to a less formidable cause. The strumous diathesis, with its tendency to pus formation, is the primary cause in a number of instances. Retro-pharyngeal abscess may occur as the result of a catarrhal inflammation in which the inflammatory process has invaded the submucous and cellular tissue, which is loose and which has a lax attachment to the mucous membrane of the pharynx; or it may be the result of a true phlegmonous inflammation in which the tissues are intensely inflamed and which passes rapidly into the suppurative stage. A large number of cases arise from inflammation and suppuration of the lymphatic glands in the posterior portion of the pharynx. In these the inflammation follows the usual course of strumous glandular inflammation, and terminates in a circumscribed abscess.

A traumatic abscess may be the result of wounds of the pharynx produced by foreign bodies. Abscess of the pharynx has also been observed as a sequence to diphtheria, scarlet fever, measles, and cerebro-spinal meningitis. Nélaton has reported a case due to metastasis in connection with perineal suppuration. In a certain number of cases no constitutional or traumatic cause can be discovered; the abscess seems to be simply the result of exposure to irritating atmospheric influences which have produced an inflammatory condition of the pharyngeal

mucous membrane. During the late epidemic of influenza an unusual number of pharyngeal abscesses have been observed.

Symptoms.—The symptoms of pharyngeal abscess vary according to the portion of the pharynx affected. When seated in the upper or middle pharynx, dysphagia is often the sole symptom. This often exists to such an extent as to preclude the taking of solid food. When situated in the lower pharynx there is often an interference with respiration, and we find dyspnœa added to the dysphagia. In a case seen by myself, in which the abscess occurred low down in the pharynx and involved the epiglottic folds, the dyspnœa was accompanied by great stridor. The constitutional symptoms vary greatly in individual cases, and depend largely upon the cause of the suppuration. In some they are entirely absent. In others they resemble the ordinary symptoms accompanying a suppurative inflammation. In children, according to Bokai, convulsions frequently accompany the disease. In acute inflammatory cases pain may be the predominating symptom, and it may be so intense as to prohibit the taking of food. In the subacute or chronic abscess pain may be entirely absent, and the sole symptom may be the dysphagia or dyspnœa. When the pus burrows in the lines of connective tissue, the symptoms will depend upon the point invaded and the subsequent glandular inflammation involved in the process. When the vertebræ are in a condition of caries, there is a tendency on the part of the patient to keep the head in a fixed position, inclining backward. When the abscess is laterally situated, the head is inclined to the sound side. A characteristic act of swallowing is seen when the subacute or chronic abscess is laterally situated. As the food or liquid is projected below the palate, through a movement of the tongue, with a sideway upward jerk of the head, the patient seeks to bring it to the free side.

Retropharyngeal abscess may occur at any age, but is seen most frequently in children. Bokai, in the Children's Hospital at Pesth, who has studied the disease through a period of twenty-six years, reports the occurrence of 204 cases. This is the largest number reported by a single individual, as very few writers have seen more than from four to ten cases.

Diagnosis.—Simple inspection of the pharynx, with the tongue well depressed, will reveal the condition when the abscess is situated in the upper part of the pharynx. Illumination with the laryngeal reflector will render it more evident. When the abscess lies in the pharyngo-larynx the laryngeal mirror will bring it into view. In the greater number of cases palpation with the finger will detect the rounded fluctuating swelling. A gummatous tumor in a state of degeneration, or a growth of the posterior pharynx, might possibly mislead the careless observer. A gumma, however, never gives the peculiar fluctuating feel of an abscess, and the hardness of the malignant growth is a marked differential point. A lymphoma or lympho-sarcoma will also be characterized by slowness of growth. In one of my cases an osteo-sarcoma of the pharynx produced the same difficulty of swallowing that is seen in retropharyngeal abscess, but a hard solid tumor could be felt low down, a little above the larynx. In this case the marked constitutional condition, with the hardness of the tumor, rendered the diagnosis certain.

In small children an abscess may be mistaken for croup, when situated near the larynx. This will especially be the case when it is situated in the laryngo-pharynx, in which case the stridulous breathing will resemble that seen in croup. There is, however, this difference: the dyspnœa and stridor of the abscess are constant and are not subject to the remissions which are usual in laryngeal croup. The voice also retains its tone, although it may be husky, and croupy cough is absent. Difficulty of swallowing will also be a marked symptom in abscess which produces stenotic symptoms, and this would be wanting in croup.

Various other pathological conditions of the larynx, including laryngeal œdema, inflammation, and growths, may simulate a pharyngeal abscess, but an inspection with a laryngeal mirror will establish the diagnosis.

The differential diagnosis between abscess from caries of the vertebræ and that which results from idiopathic phlegmonous inflammation or from suppuration of the lymphatic glands, will be found in the history of the case. Idiopathic abscess due to phlegmonous inflammation usually runs a rapid course, and suppuration is manifested in a few days. Abscess from lymphangeitis is somewhat slower, but its acute character is manifest. In caries of the vertebræ tenderness of the affected vertebræ is present, and the abscess is slowly developed, sometimes assuming the characteristics of cold abscess.

Prognosis.—The prognosis of retropharyngeal abscess depends strictly upon its cause. The idiopathic abscess, whether the result of phlegmonous inflammation or of glandular disease, will, in the vast majority of cases, give a rapid recovery after incision and emptying of the sac, and spontaneous evacuation of the pus will be followed by an equally happy result. According to Bokai, out of 129 cases of pharyngeal abscess only 5 proved fatal. In adults recovery is the rule, although a fatal result has been noted by some observers. Rupture of the abscess, with an entrance of pus into the larynx and air-passages, has been followed by pneumonia. Several writers have reported cases of rupture of the carotid artery and fatal hemorrhage. Œdema of the glottis may be the result of an abscess through extension of the inflammation. The prognosis in a case due to caries of the vertebræ is most unfavorable. Syme reports a case in which recovery took place after exfoliation of the greater part of the second cervical vertebra, and Gunther reports recovery after the removal of the third and fourth cervical vertebræ. Such recoveries must be rare. Roe makes a point which is worthy of further observation when he maintains that in certain cases of abscess associated with superficial caries of the vertebræ, the caries may be the result simply of pressure of the pus sac. In such a case evacuation should give permanent relief. An analogous condition is seen in caries of the vertebræ from the pressure of an aneurismal tumor.

Treatment.—The treatment of retropharyngeal abscess consists in evacuation of the pus, as soon as the proper time for the operation has arrived. In the earlier stages, hot soothing drinks and the use of anodyne sedative inhalations give a certain amount of relief. A gargle of hot water with bicarbonate of sodium, and the application of a hot cataplasm about the neck are grateful. Some prefer the use of cold applications in the earlier stages, and advise the employment of small

pieces of ice, or ice cream, allowing these to melt in the mouth, with the application of an ice bag or a Leiter coil with iced water about the neck. As soon as the presence of pus is detected, the use of the knife is promptly required. An emetic will occasionally, in children, be sufficient to rupture the abscess, but such a procedure is not without danger from the pus entering the larynx. Some writers advise the opening of the abscess with a trocar and canula, but if proper precautions are taken this will be unnecessary. The danger of the pus entering the larynx has, in my opinion, been largely exaggerated, for if proper precautions are taken such a result can hardly occur.

An essential feature of the operation is to quickly lower the head, as soon as the incision has been made, so that the pus may flow upward to the mouth. An admirable plan is to place the patient on his stomach on a high table, one end of which can be raised to an angle of about forty-five degrees, with the head downward, projecting over the edge. This position is convenient for the operator, and more comfortable for the patient than to allow the head and upper extremities to hang over the table with the head downward. As soon as the puncture has been made the pus gushes downward and out of the mouth. Children may be held on the lap and quickly reversed as soon as the cut is made.

In abscess of the upper pharynx an ordinary bistoury may be used, but in deeper abscesses the pharyngotome is more advisable. It should have a more rounded curve than is usually given to the laryngeal lancet.

The tumor is first covered by the finger of the left hand, and the knife is guided along the finger until the proper point has been reached. It is then inserted and a free incision is made. With a finger guard on the left forefinger the tongue may be depressed at the same time that the knife is guided, and in this way the use of a tongue depressor, which has been strongly recommended, may be altogether dispensed with. It has been advised by some to chloroform the patient, but this is not only unnecessary but even dangerous, as he will need his faculties to assist the operator.

INTUBATION OF THE LARYNX.

BY

HENRY R. WHARTON, M.D.,

DEMONSTRATOR OF SURGERY IN THE UNIVERSITY OF PENNSYLVANIA, SURGEON TO THE PRESBYTERIAN, METHODIST, AND CHILDREN'S HOSPITALS; ASSISTANT SURGEON TO THE UNIVERSITY HOSPITAL, ETC., PHILADELPHIA.

THE operation of intubation of the larynx consists in passing a specially constructed metal tube through the mouth into the larynx, for the relief of dyspnœa resulting from laryngeal stenosis. Since the introduction of this operation by O'Dwyer, in 1880, it has been employed both in this country and abroad in many thousands of cases of obstructive dyspnœa, and is now generally recognized as a valuable surgical procedure for the relief of that condition developing in cases of diphtheritic and membranous croup, or in cases of cicatricial stenosit of the larynx, œdema or spasm of the glottis, bilateral paralysis of the abductors, or paresis of the cords from disuse. The indications for the operation of intubation of the larynx in cases of obstructive dyspnœa are similar to those which are recognized as calling for the operation of tracheotomy for the relief of this condition.

PROGNOSIS.—The number of recoveries following the operation of intubation of the larynx is very similar to the number following tracheotomy. Ranke, in an analysis of 2500 cases of intubation, mostly from hospital practice, found that in the first year of life intubation gave apparently better results than tracheotomy, 13 per cent. of recoveries in contrast to 5.4 per cent. by the latter operation; in the second year intubation gave 32.3 per cent. of recoveries against 25.4 per cent. by tracheotomy. Ball, in a collection of 4217 cases of intubation gathered from American and European sources, found that there were 1285 recoveries, or about 30.4 per cent. Ball's statistics show that

60	cases	under	1	year	of	age	gave	11	recoveries,	or	18.3	per cent.
253	"	"	2	years	"	"	"	48	"	"	19.0	" "
306	"	"	3	"	"	"	"	67	"	"	21.9	" "
326	"	"	4	"	"	"	"	98	"	"	30.0	" "
231	"	"	5	"	"	"	"	93	"	"	40.0	" "
127	"	"	6	"	"	"	"	48	"	"	37.8	" "

Ranke's statistics show that intubation gives better results than tracheotomy in the first and second years of life; from this age the difference between the two operations as far as recoveries go is not very marked. Too much reliance should not be placed upon these comparative statistics, for many operators perform intubation at a time when the dys-

pnœa is not extremely urgent, and when they would hesitate to employ tracheotomy; so that it is probable that the milder cases are treated by intubation, while tracheotomy is reserved for those which are more severe.

INSTRUMENTS REQUIRED FOR INTUBATION.—The instruments employed in the operation of intubation of the larynx are: Intubation-tubes of various sizes; an introducer; an extractor; a mouth-gag; a gauge; fine braided silk.

The *intubation-tubes* are furnished for children and for adults; those for children are usually six in number, adapted to children from one to twelve years of age. The intubation-tube now generally employed consists of a metal tube which bulges near its centre, and is provided with a collar or head to rest upon the false vocal cords; it is irregularly quadrangular in shape, one angle resting upon the arytenoid cartilages, and its opposite angle bevelled to permit of the closure of the epiglottis over the aperture of the tube; the tubes are gold-plated, and each is provided with an obturator which has a blunt extremity. Just below the head, the tube is of small diameter, to avoid injurious pressure upon the vocal cords. The wall of the tube is increased to its greatest diameter about the middle, which serves to maintain it in position during coughing, and increases the weight so that it is expelled with more difficulty. A small perforation exists at the edge of the collar on each tube, through which a strand of fine braided silk is passed, which gives the operator control of the tube, permitting him to remove it promptly if in its introduction it should be accidentally passed into the pharynx or œsophagus, instead of the larynx, or if after its introduction its withdrawal should be indicated by sudden obstruction by membrane.

The *introducer* consists of a handle and staff, which is curved to a right angle at its extremity; at the end of the staff there is a screw by which it is attached to the obturator, and to it is attached a sliding-gear for detaching the obturator from the tube when it has been placed in the larynx.

Mouth-gags of various kinds may be used; the one generally furnished with intubation sets is a self-retaining instrument.

The *extractor* is also curved to a right angle, and has a small forceps with duck-bill blades at its extremity; these are made to separate and apply themselves to the inner surface of the intubation-tube with sufficient firmness to allow it to be withdrawn.

A metal *gauge* also is provided, which is used to determine the size of the tubes to be employed for children of different ages.

PREPARATIONS FOR INTUBATION.—The actual introduction of the intubation-tube should occupy as little time as possible, for as soon as it enters the larynx breathing is arrested until the obturator is removed; therefore all manipulations should be as rapid as may be consistent with accuracy. The time usually required for the introduction of the intubation-tube and withdrawal of the obturator is from five to ten seconds after the mouth-gag has been properly adjusted. The surgeon before undertaking the operation of intubation should select a tube of suitable size for the age of the patient, and should pass through the eyelet in the tube a strand of fine braided silk, about two

feet in length, and secure it with a knot. The tube should next be attached by means of the obturator to the introducer, and the operator should then see that it can be easily freed from the obturator by working the trigger; this is very important, for if it does not work freely he may find that he cannot remove the obturator after the tube has been introduced into the larynx, and he may be compelled to remove the tube. The mouth-gag with the tube and introducer should be placed in a basin of warm water. The surgeon should now protect the index finger which is to be passed into the mouth of the patient to guide the tube in place, by wrapping it for an inch or an inch and a half behind the second joint with rubber or adhesive plaster, or by placing upon it a metal shield. This precaution is most important to prevent the finger being bitten in case the mouth-gag slips and allows the jaws to come together, for a bite from the teeth, which in diphtheritic cases are often very foul, might be followed by a disastrous result.

POSITION OF PATIENT FOR INTUBATION.—The child should be held erect upon the nurse's lap, wrapped in a blanket which should cover it from the neck to the feet, and the nurse should secure the child's elbows outside of the blanket and hold them firmly, but should not press them against the chest firmly enough to embarrass the respiratory movements. The legs of the patient at the same time should be secured by being held between the knees of the nurse. The patient's head should next be secured by being held between the open hands of an assistant, placed one on either side of the head and cheeks; the assistant may at the same time hold the mouth-gag after it has been introduced, with the left hand. The patient should be held as erect as possible, and the nurse should take care not to allow him to lean so far back that he gets out of the reach of the operator. The erect position is the best one in which to place the child for intubation, but it is also possible to introduce the intubation-tube while the patient is lying down. I have on several occasions introduced intubation-tubes while patients were in the recumbent posture, in cases in which I did not think it advisable, from the condition of the circulation, to place them in the erect position.

OPERATION OF INTUBATION.—When the child has been placed as above described, facing the surgeon, who sits within easy reach of the patient, the assistant fixes the head, and the surgeon opens the mouth and introduces the blades of the mouth-gag between the molar teeth of the left side; the mouth is next widely opened by compressing the handles of the gag, and the assistant holds the gag with the fingers of the left hand. As soon as the mouth has been widely opened, the surgeon passes the index finger of the left hand, protected by means of the plaster or with a metal shield, into the mouth, and carries it back to the pharynx and feels for the epiglottis; when this is recognized it is hooked forward with the finger; the intubation-tube attached to the introducer is next passed into the mouth and carried back to the pharynx, the operator observing that in its introduction it hugs the base of the tongue in the middle line, and that the handle of the instrument is depressed well upon the child's chest; he should also see that the silken thread attached to the tube is not entangled in the instrument. When the extremity of the intubation-tube comes in contact

with the end of the finger resting against the epiglottis, the handle of the instrument should be raised as this is pushed downward and forward into the larynx, and as it sinks into the larynx the finger is placed upon the head of the tube to fix it, and prevent its withdrawal when the obturator is removed. As soon as the tube has been pushed well down into the larynx respiration ceases, and further manipulations should be made with as much speed as possible; the trigger should be pressed to disengage the obturator and introducer from the tube, which is fixed in the larynx by the tip of the finger as before described. The introducer and obturator are now withdrawn from the mouth by depressing the handle of the instrument upon the chest, and before the finger is removed from the mouth the tube should again be pressed well down into the larynx.

No great amount of force should be employed in pressing the tube down after it engages in the larynx; I think it may be given as a safe rule of practice, that no more force should be used than would be justifiable in passing a catheter or bougie into the urethra. If it is found that the intubation-tube is too large to be passed into the larynx without the exercise of considerable force, it should be withdrawn, and a smaller one should be attached to the instrument and introduced. Usually, as soon as the obturator has been removed, the child makes a deep inspiration, and at the first expiratory effort there is commonly coughed up false membrane or muco-purulent matter, and when the tube has been cleared of this the respiration is carried on quietly; if, however, upon the withdrawal of the obturator, the dyspnœa is not relieved by the expiratory efforts of the patient, the tube should be speedily removed by traction upon the thread and examined, and if it is found that no mass of membrane is occluding it, the canal being clear, and that dyspnœa is still present, it is evident that the obstruction exists below the point to which the intubation-tube extended. Under such circumstances it is not likely that a second introduction would afford relief, and it is better to make no further attempt to introduce the tube, but to resort to tracheotomy. If, on the other hand, the respiration is carried on satisfactorily, before the mouth-gag is removed the index finger of the left hand should be introduced and carried back to feel that the tube is in place, and has not been disturbed by the expiratory efforts of the child.

Some diversity of practice exists among operators as to the disposition of the silken thread which is attached to the intubation-tube; some operators as soon as the tube is properly placed and the patient is breathing comfortably, divide the loop of silken thread, and with the finger resting upon the head of the tube, pull upon the end of the loop and withdraw it; this is done to prevent the irritation of the fauces which the thread sometimes causes, and to prevent the patient from seizing it and displacing the tube. Other operators prefer to retain the thread in place for some hours or days, so that the loop can be brought out of the mouth and secured around the ear, and can be used to remove the tube, by traction upon it, in case it should become blocked with membrane and is not coughed out by the patient. To prevent the irritation of the fauces and the gagging which the thread sometimes causes, it has been suggested that it should be passed through the posterior nares, and be brought out anteriorly and secured around the ear,

or to the face, by a strip of plaster. I usually allow the thread to remain in place for from twelve to twenty-four hours, bringing it out at one angle of the mouth, and passing the loop around the ear, and securing the thread to the face by a strip of rubber plaster extending from the ear to the angle of the mouth; this prevents the child grasping it and displacing the tube. To prevent the child biting the thread, where it is possible, I also pass the thread between the molar or premolar teeth. In cases where a child has a tendency to grasp the thread, it is well to enclose the hands in mittens or stockings, and secure them to a band fastened around the waist.

The most common mistake which is liable to occur in introducing an intubation-tube is to pass it over the epiglottis and into the pharynx, but this error is discovered as soon as the obturator is withdrawn, and the tube should then be removed by the attached thread and reattached to the introducer, and another attempt should be made to pass it into the larynx. This error I have often seen occur in the hands of both experienced and inexperienced operators, and I think it is due to the fact that in introducing the tube they are not careful enough to hug the base of the tongue closely with its end, and to keep it strictly in the median line. The operator is less liable to make this mistake if he is mindful of the position of the index finger of the left hand, which should be held in contact with the epiglottis, and which serves as a guide to the opening of the larynx.

Accidents During and After Intubation.—Accidents may occur during the operation of intubation, such as pushing a mass of membrane down into the trachea before the tube, or a too deep insertion of the tube may be made so that its head passes below the vocal cords; accidents of this nature have been reported, but I personally have never had any serious accident occur during the operation. One of the most serious accidents is the pushing downward of a mass of membrane before the intubation-tube, which is likely to embarrass the respiration so seriously that in the violent expiratory efforts of the child the tube may be forced out of the larynx; if, however, this does not occur, the tube should be removed by traction upon the thread; and if, after its removal, respiration is still seriously embarrassed, tracheotomy should be promptly performed. The too-deep insertion of the intubation-tube into the larynx, so that its head passes below the cords, is not likely to occur if a tube of the proper size and shape be employed; a tube which is too small may be readily forced between the vocal cords, or may be drawn down into the trachea by the inspiratory efforts of the child, after it has been introduced. If this accident should occur, and the respiration be seriously embarrassed or arrested, the tube can quickly be removed by traction upon the thread, but if it should occur after the removal of the thread it would be necessary to open the trachea to accomplish the removal. Several cases of this nature have been reported in which it was necessary to resort to tracheotomy to accomplish the removal of a misplaced intubation-tube. It often happens that after an intubation-tube has been retained for a few days, it is coughed up, and upon being replaced the same accident occurs again. Under such circumstances a larger tube should be tried, and if it cannot be tolerated by the larynx, and is displaced, if the dyspnœa is still present, further

attempts at intubation should be abandoned, and tracheotomy should be resorted to. It sometimes happens that the intubation-tube from which the thread has been removed is displaced from the larynx by coughing, and passes into the pharynx, and is swallowed. This seems like a serious accident, but I have never known of a fatal result to follow the occurrence, as the tube is usually passed through the alimentary canal without difficulty. Personally, I have never seen any serious accidents happen during the operation of intubation, or while the intubation-tube was in place, but I always bear in mind the possibility of such accidents occurring at the time of operation, and during the period the tube is worn, and always have at hand my tracheotomy case so that I may promptly open the trachea if necessary, and would advise all operators who make use of intubation to be similarly prepared.

AFTER-TREATMENT OF CASES OF INTUBATION.—A patient who has had an intubation-tube introduced should be under the care of a nurse, who should be instructed as to the management of any emergencies which may arise while it is in place. If dyspnœa suddenly develops from obstruction of the tube by a piece of loose membrane too large to pass through it, and the tube is not displaced by the violent expiratory efforts of the patient, the nurse should be instructed to attempt its removal by traction upon the thread, if this has been left in place, or if the thread has been withdrawn she should invert the child, when by striking over the posterior portion of the chest, or by pressure upon the larynx from below upward, she may be able to dislodge the tube. A case has been reported recently in which a nurse saved the patient's life by this manipulation. In the after-treatment of cases of intubation, I have the patient inhale a spray of Parker's soda solution, applied by means of a hand or steam atomizer. The solution I refer to contains

Sodii carbonatis	ʒ i.–ʒ ij.
Glycerinæ	f ʒ i.
Aquæ	q. s. ad f ʒ vi.

I also often employ a spray of peroxide of hydrogen diluted one-half with water, both being efficient in dissolving membrane and liquefying secretions. I usually have the spray used every half-hour, or more frequently if there is little tendency to expectoration. The use of the soda spray is most important in what are commonly described as dry cases.

FEEDING OF PATIENTS AFTER INTUBATION.—The feeding of the patient is the most difficult portion of the after-treatment of cases of intubation. The act of deglutition is often seriously interfered with by the presence of the tube, as from the imperfect action of the epiglottis liquids are apt to pass into the larynx, causing choking and setting up coughing, which interferes with taking a sufficient quantity of nourishment; and this interference with the proper nourishment of the patient constitutes, in my mind, one of the most serious objections to the operation of intubation. I find, as a rule, that patients wearing intubation-tubes have difficulty in swallowing liquids, but some are occasionally met with who swallow liquids without difficulty; therefore it is

well to make a trial as to the feeding before special diet is ordered for any individual case. Some patients wearing intubation-tubes will learn to swallow with the tube in place; I have seen children who at first were unable to take liquid nourishment, in a few days change their manner of swallowing so that liquids could be taken without discomfort. Where marked difficulty is experienced in swallowing liquids, I order a diet of semisolids, such as corn-starch, mush, milk-toast, curd, or soft-boiled eggs, and as patients soon experience thirst, I order pieces of ice to be swallowed, or give enemata of water, an ounce to an ounce and a half, to be repeated at intervals. In the case of infants, for whom a milk diet is essential, it will often be found that the child can swallow well if fed from a nursing-bottle or the breast, the head being dropped over the nurse's lap so that it is lower than the body; this latter expedient was suggested by Casselberry, of Chicago. In some cases where the above expedients fail as regards the feeding of patients, it will be found necessary to resort to the introduction of food by nutritious enemata or by means of a stomach-tube.

REMOVAL OF INTUBATION-TUBE.—The intubation-tube usually remains in place for four or five days, but it is often coughed out before this time as the swelling of the laryngeal tissues subsides, and if there be no dyspnœa it need not be replaced; the surgeon, however, should bear in mind that for a few days dyspnœa is liable to return, so that the reintroduction of the tube may be necessitated, and he should be within reach of the patient during this time; if, however, it has not been coughed out, and the child's general condition is improving, the temperature having a tendency to reach the normal mark, the tube may be removed at the end of three or four days, and if there is no return of the dyspnœa it need not be reintroduced; but the case should be kept under careful observation, for the patient is not safe for several days more. If, on the other hand, dyspnœa is present after the withdrawal of the tube it should be promptly replaced, and no further attempt should be made to dispense with it for a period of two or three days. In from five to ten days the tube can ordinarily be definitively withdrawn, although I have had recently under my care a case in which it could not be permanently removed until the fifteenth day. After the removal or expulsion of the intubation-tube, if the breathing is carried on satisfactorily, I continue for two or three days the use of the soda spray, and have the patient carefully watched so that he is not exposed to cold. In all cases in which recovery has followed intubation of the larynx I have noticed that there has been a considerable amount of hoarseness of the voice, which, however, usually disappears in a few weeks.

As the same intubation-tubes may be used in many different cases, it is most important that they should be thoroughly sterilized by boiling for a few minutes after their removal, and thoroughly cleaned and polished before being again employed.

More difficulty is often experienced in removing an intubation-tube than in its original introduction. For removing the tube the patient should be placed in the same position as that already described. The mouth-gag should be used to separate the jaws; the index finger of the left hand should be protected, and should be passed into the mouth and

placed on the head of the tube. The extractor should be next introduced, and, with the finger on the head of the tube as a guide, the blades should be passed into the opening of the tube. By pressing the lever which separates the blades, the tube is grasped by them, and is withdrawn by depressing the handle upon the patient's chest. In passing the forceps into the opening in the intubation-tube, difficulty is sometimes experienced, but if the finger is placed upon the head of the tube as a guide this should not occur. During the withdrawal the blades may slip, losing their hold upon the intubation-tube which may then pass into the pharynx and be swallowed. This accident may be prevented by following the tube by the finger as it is withdrawn from the larynx, when if it becomes detached from the extractor it can be hooked forward by the finger and removed.

In the treatment of dyspnœa resulting from diphtheritic or membranous laryngitis, or from œdema or spasm of the glottis, intubation of the larynx has proved a valuable surgical procedure; cases of membranous or diphtheritic laryngitis, where obstruction comes on rapidly and is probably largely due to œdema of the mucous membrane, are in my judgment the most favorable for intubation. Statistics show that children under two years of age are better subjects for this operation than for tracheotomy. Intubation of the larynx seems to me also to be especially well suited for cases of dyspnœa due to œdema of the laryngeal mucous membrane from burns or scalds, from the swallowing of corrosive liquids, or from the inhalation of irritating gases, unless there is at the same time marked œdema of the epiglottis and fauces. Cases of diphtheria in which the dyspnœa is largely due to great swelling of the tonsils and fauces, with profuse deposit of membrane in these situations, as also those in which the dyspnœa comes on very slowly, pointing to a gradual deposit in the larynx of a well-organized membrane, are unfavorable cases for the operation of intubation. The operation usually relieves the urgent symptoms, is practically free from danger, is a bloodless procedure, and the consent of the parents for its performance can usually be obtained without difficulty; the inspired air, too, enters the lungs warm and moist, and if it fails to relieve the patient it does not preclude a subsequent tracheotomy; these are the principal advantages claimed for intubation over the latter operation. It is stated by some authorities that the prognosis in cases of tracheotomy after intubation is not favorable, but my personal experience does not agree with this statement; for I have opened the trachea in a number of patients in whom a fair trial of intubation had failed to relieve the dyspnœa, and the results following the operation have been in nowise less satisfactory than those in which tracheotomy has been resorted to as a primary operation.

Intubation in Chronic Stenosis of the Larynx.—The operation of intubation has been successfully employed to relieve the dyspnœa resulting from chronic stenosis of the larynx, and it has been found that an intubation-tube can in these cases be worn for a considerable time without inconvenience. It has been employed in cases of chronic syphilitic stenosis, cicatricial contraction, bilateral paralysis of the abductors, paresis of the cords from disuse, and in cases where there is difficulty in permanently dispensing with the tracheotomy-tube from

the presence of granulations in the region of the tracheal wound, or from the dread of having the tube removed; in such cases the manipulations for the introduction of the intubation-tube are similar to those employed in acute cases, with possibly the difference that more force is justifiable in the introduction. In these cases the tube should be changed at intervals of a few days, a larger-sized tube being required from time to time. Little difficulty usually occurs in feeding the patient, as liquids are commonly taken without trouble after the tube has been worn for a short time.

INJURIES AND DISEASES OF THE CHEST.

BY

RICHARD H. HARTE, M.D.,

DEMONSTRATOR OF OSTEOLOGY IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PENNSYLVANIA HOSPITAL AND TO THE EPISCOPAL HOSPITAL; CONSULTING SURGEON TO ST. MARY'S HOSPITAL AND TO ST. TIMOTHY'S HOSPITAL, PHILADELPHIA.

CONTUSIONS OF THE CHEST.

CONTUSIONS OF THE THORACIC WALL.—By the peculiar mechanism of the chest, all forces received upon its walls are distributed over twenty or more elastic springs. By this means, and especially when the lungs are distended with air, an astonishing amount of resistance is offered to external violence, without any serious injury being sustained by the thoracic wall or by its contained viscera. As the result of its elasticity, especially upon its anterior portion, ecchymosis and circumscribed blood-tumors are seldom met with, as on the head and buttocks, although over the scapular region occasionally large sanguineous collections will be found as the result of direct impact. Another common form of chest contusion is by indirect force, where the body is caught and squeezed, or rolled, between two unyielding bodies, as between a cart and a wall. In this class of contusions the external evidences of injury are negative, and in case of death an autopsy throws but little light upon the subject. The principal symptom is pain, aggravated by movements of respiration, coughing, or sneezing, and by pressure. Although the pain may be very severe, it is less than when the contusion is complicated by fracture of the ribs or by rupture of the viscera. In this class of injuries the pain is more liable to be persistent than in ordinary contusions, owing to the fact that not infrequently at the articular ends of the ribs, both at the heads and tubercles, the ligaments are stretched, and synovitis of many of these small joints is set up, causing even slight respiratory motion to be accompanied by pain.

The most common injury to the chest is fracture of the ribs, the broken ends of which not infrequently wound some of the deeper structures. Much of the disability which follows what are regarded as simple contusions of the chest is really due to a fracture of one or more ribs which has not been recognized, the diagnosis being often much more difficult than might be supposed, from the fragments being held on both sides by the unyielding chest-wall and intimately attached muscles.

The chief symptom of these injuries is pain, which is especially marked upon forced respiration, as in coughing or sneezing, and may be elicited by firm pressure made along the course of the injured rib by the end of the finger; whereas with diffused pressure, made with the flat of the hand, the pain will often be overlooked, except one hand be placed over the sternum and the other over the vertebral ends of the ribs, with firm pressure and counter-pressure, when the injury may be located with a fair degree of accuracy. Again, the pain may be due to a bruising or laceration of the muscles, especially the pectoralis major, as might follow a similar injury in any other part of the body.

Treatment.—The chief indication in the treatment of these cases is to procure as nearly absolute rest as possible, which can only be done by immobilizing the injured side so as to limit its motion during respiration. This is best effected by the use of carefully applied strips of adhesive plaster, two inches wide, of sufficient length to extend from the sternal border of the sound side to the vertebral border of the same. The strips should be applied firmly, commencing at the lower margin of the ribs, in extreme expiration, and should be carried up, each strip overlapping one-half of that previously applied, to the axilla. When this point is reached, the scapular and subclavicular spaces must be covered in the same manner by applying the strips obliquely, thus covering in and immobilizing completely the injured side. The application of a tight broad bandage over the strips of plaster, as is often advised, is undesirable, as it tends to interfere with the action of the sound side.

CONTUSIONS INVOLVING THE THORACIC VISCERA.—The deeper structures of the thorax do not always escape, even if the external injury is slight. There may be a rupture of the great vessels of the lungs, or a rupture of the heart or pericardium. Less severe contusions may involve the pleura or parenchyma of the lung, causing hemorrhage, which may be followed by pneumonia or by gangrene. Pleural and lung wounds are caused in many instances by the sharp ends of fractured ribs, in cases in which little or no contusion of the viscus has existed, and in which extensive emphysema often follows. One of the most characteristic signs of rupture of the lung, not dependent upon fracture, is emphysema making its appearance at the root of the neck or in the epigastric region. Rupture of the lung in the true sense implies extensive hemorrhage into the chest and bronchi, with expectoration of blood and frothy mucus.

The heart and pericardium have also been ruptured, and the heart torn from its attachments. These extreme injuries are usually the result of crushing forces causing fracture of the sternum or ribs. The heart appears to experience the result of concussion much in the same manner as the brain, and fatal results have followed when an autopsy has failed to reveal any apparent alteration in the cardiac structure. When these severe contusions are received on the lower portion of the chest, occasionally the liver or kidney may be ruptured; injury of the latter viscus may escape detection until revealed by post-mortem inspection. The prognosis in these cases depends largely upon the presence or absence of serious injury to the viscera, grave lesions of which are, as a rule, accompanied by much shock.

WOUNDS OF THE CHEST.

NON-PENETRATING WOUNDS.—Wounds of the chest are conveniently divided into non-penetrating and penetrating wounds. The non-penetrating variety comprises all punctures and lacerations involving the soft parts about the chest-walls. They are rarely of a serious character, except when a large artery is severed, such as the subscapular, which may bleed freely for a time, but is easily controlled. The greatest care must be exercised in the examination of deep, non-penetrating wounds, that they are not needlessly converted into penetrating wounds, especially in attempting to locate the missile in cases of gunshot injury. In most cases the diagnosis may easily be made if the character of the vulnerating body is known. Emphysema is often present, and is due to the sucking of air into the cellular tissue around the wound by the bellows-like action of the chest-walls, and its presence is not in any way pathognomonic of wounds of the lung. I am familiar with a case in which extensive emphysema occurred, involving the regions over the perineum, buttock, and abdomen, up to the axilla, as the result of a perineal abscess opening into the rectum. Care must be taken to differentiate between emphysema and gaseous cellulitis. A case of the latter is reported by Dungern,[1] in which this condition followed extirpation of the rectum. Dungern believed the presence of air to be due to gas-producing bacilli which were found in abundance in the cellular tissue.

Treatment of Non-penetrating Wounds.—If foreign bodies are lodged or embedded in the ribs, they must be removed, and the bleeding controlled as soon as possible. If muscles are divided, they must be accurately united by buried catgut sutures. If the deeper layers of fascia are opened, drainage must be secured from the most dependent portion, and dressings should be applied as to like wounds in other parts of the body, care being taken to immobilize the chest-walls as much as possible, as their movements will have a tendency to delay union. The more remote dangers are those due to septic absorption—tetanus, erysipelas, gangrene, etc. The possibility of pleurisy or pneumonia following, with their sequelæ, must not be overlooked. In rare cases peritonitis or pericarditis may be developed in an unlooked-for manner, probably as the result of septic embolism.

PENETRATING WOUNDS OF THE CHEST.—These may be subdivided into those opening into the cavity of the thorax and those implicating the viscera. They may be of the most varying character, from the slightest puncture, as by a knitting needle, to the greatest destruction of substance, as by the end of a wagon pole. These wounds are dangerous from the accompanying hemorrhage, destruction of lung tissue, entrance of septic material, etc.

In penetrating wounds of the chest, no matter from what cause, the lung is usually injured, and the two most characteristic signs will be bleeding and the presence of pneumothorax with emphysema. Hemorrhage may occur into the bronchi, when the expectorated matter may consist of pure blood, or of a frothy light-red mixture, which in a few

[1] Münch. med. Wochenschr., Bd. xl., S. 747, 1893.

days becomes rusty or black; or the blood may escape into the cavity of the pleura, and be slowly expelled with each respiratory act through the external wound, or may remain until it distends the cavity (*hæmothorax*) and compresses the lung against the back. In rare cases, when the air vesicles alone are torn, without injury to the pleura, air may escape into the cellular tissue of the lung and make its way along the outside of the bronchi to the mediastinum, and so gain the root of the neck; or, which is most common, it may find its way into the pleural cavity (*pneumothorax*) and from thence enter the cellular tissue, causing surgical *emphysema;* or, if the wound be large, it may be sucked in and out of the chest during respiration (*tromatopnœa*), being more or less mixed with blood. Dyspnœa is always present to some degree, and if the lung rapidly collapses it is extreme. The shock in such injuries is severe and often fatal, even when but little hemorrhage has occurred. If the lung has escaped, the diaphragm may be paralyzed from injury to the *phrenic nerve;* or, if the heart be feeble and tremulous in its action, injury to the *pericardium* or its nerve supply, or simple *concussion of the heart* may be suspected. In penetrating wounds of the chest extensive hemorrhage may take place without the lung having been injured, especially in gunshot wounds involving the *intercostal* artery or the *internal mammary.* I once saw fatal hemorrhage follow wounding of the vena azygos major by the blade of a small knife, the nature of the injury being revealed by post-mortem examination. The bleeding in these cases is often internal or concealed, and the treatment varies with the nature of the case. If the source of hemorrhage can be located with any degree of accuracy, the wound should be carefully enlarged and the bleeding point sought for, even if resection of several ribs should be necessary.

Injury to the Heart and Pericardium.—In comparison with the lung the heart is seldom injured, except in suicidal attempts, and even then it frequently escapes owing to the popular opinion that this viscus is entirely upon the left side of the chest. In rare cases the pericardium, or the surface of the heart, may be injured and yet the patient recover, but as a rule these cases are fatal. Occasionally the heart has been wounded by the entrance of fish bones or pins driven through from the walls of the œsophagus. Recovery in *non-penetrating wounds of the heart* is said to take place in about fifteen per cent. of all cases, but this estimate is undoubtedly too high. *Penetrating wounds of the heart* are, as a rule, fatal, although death is not always immediate, especially if the wound is made with a sharp instrument, which does not produce much concussion. I had under my care a patient who lived for nearly four hours after a penetrating wound of the left ventricle, one and one-half inches in length, made by the blade of a butcher's knife. Death takes place in these cases largely from the effusion of blood into the pericardium, slowly but effectually embarrassing the heart's action.

The *diagnosis* of heart wounds, where external signs are absent, may be made by noting the extreme shock, dyspnœa, and almost instant failure of the circulation. The heart sounds are usually inaudible, but occasionally splashing or other abnormal sounds may be heard.

In the *treatment* of these cases absolute rest should be enforced. External cold over the pericardium, and opium internally, may be found of service. The external wound may be closed, this being best done by

packing it firmly with sterilized gauze. If closed by sutures, concealed hemorrhage into the chest is liable to continue.

The *great vessels* of the thorax may be injured in cases of penetrating wound, and as a rule accidents of this kind are often more rapidly fatal than lesions of the heart itself.

The *thoracic duct* may be injured as the result of deep penetrating wounds. A case has recently come to my notice in which the duct was wounded in the removal of some deep cervical glands. If the wound is within the chest, large quantities of a milk-like fluid will be poured into the pleural cavity during the process of digestion, until the sac becomes quite distended with chyle.

The *prognosis* in these cases is most unfavorable, as starvation is inevitable. In the case above referred to rapid emaciation ensued.

The *diaphragm* may be injured in a variety of ways; thus it may be ruptured by extreme compression, punctured by stabs or gunshot wounds, or torn by fragments of ribs after fracture. Frequently some of the neighboring viscera may be injured, or some of the abdominal contents may be squeezed up through the opening into the thorax, causing great pain and dyspnœa and giving rise to a diaphragmatic hernia; if the rent be small, immediate strangulation may result.

Treatment of Penetrating Wounds of the Chest.—This depends upon their character and extent. In grave cases, as of wounds of the large vessels, which are nearly always rapidly fatal, surgery has but little to offer. Where the danger is not so immediate, the surgeon is warranted by the persistence of hemorrhage in seeking for the bleeding point, enlarging the wound, and if needful even resecting several ribs. When the bleeding is from the *internal mammary artery*, a strong silken ligature should be carried around the vessel with a curved needle, and all the tissues, including the artery, should be firmly grasped within its loop. The *intercostal* vessels are seldom the seat of much hemorrhage, provided that they are cut across and can retract into their sheaths. If partially severed or punctured, the opening in the vessel will remain patulous and troublesome bleeding may result, requiring a ligature which if necessary may be carried around the adjoining rib. External hemorrhage is much better controlled by plugging with gauze than by closing the wound with sutures, which might be followed by concealed bleeding. It is important to remember that needless exploration with the probe, especially in gunshot wounds, should be avoided, as little can be thus learned which could not otherwise be ascertained, while by probing blood-clots are broken up and septic material may be introduced. The control of hemorrhage, the thorough cleansing and disinfection of the wound, and immobilizing the chest-walls, must be carefully attended to. The judicious administration of opium and diffusible stimulants is commonly indicated, and the wound must be carefully dressed with antiseptic precautions.

The amount of destruction which may follow what appear to be simple wounds will be illustrated by the following case:

T. S. was admitted to the Pennsylvania Hospital with a pistol-shot wound, 32 calibre, of the lower chest, the ball entering between the eighth and ninth ribs in the anterior axillary line. The patient suffered from shock, but lived twenty hours. Post-mortem examination revealed the track of the ball as follows: Entering at the left interspace between the eighth and ninth ribs, it had pierced

the diaphragm at its attachment to the ninth rib and had crossed the upper portion of the abdominal cavity, piercing the left crus of the diaphragm, and resting in the areolar tissue in front of the spine. In its passage it entered the epiploic appendages of the colon, penetrated the jejunum about three feet from its beginning, cut off almost the entire tail of the pancreas, and removed a wedged-shaped piece from the upper border of the left kidney. The abdominal cavity was filled with blood-clots.

In this case enlargement of the wound and careful exploration had failed to give any definite information as to the course of the ball.

COMPLICATIONS OF CHEST WOUNDS AND THEIR SEQUELÆ.—Hernia of the lung, or *pneumocele*, is produced by a portion of the lung insinuating itself through the lips of the chest wound. This may be immediate, or it may follow after several months, the protrusion overcoming the resistance of an insufficient cicatrix. The cause of this rare condition, as suggested by Agnew, is possibly the unusually deep fissures in the lungs of some persons, leaving a pendulous portion or edge which finds its way through an external break or opening in the chest-walls. Primary pneumocele is easily recognized by its crepitating character. When the hernia is secondary, and covered by integument, a marked change will be noticeable during respiration, the tumor alternately increasing and diminishing in size. In an unusually large hernia of the lung under my care the tumor was compressible and markedly crepitant, with a distinct, clear percussion note, and on auscultation gave an unusually loud rasping murmur. If an acute pneumocele is non-adherent, it should be thoroughly cleansed and, if possible, restored to the chest-cavity and retained there by suitable compresses. When adherent and projecting through a wound, it is likely to become strangulated by the entrance of blood and air, in which case it will soon slough off. It will be found best to anticipate this occurrence and transfix its base with a double ligature, as deeply as may be found necessary. In secondary pneumocele the swelling may be protected with a suitable shield retained by a bandage.

Emphysema has already been referred to several times. By this term is meant the presence of air in the cellular tissue outside of the chest-wall. If no external wound is present, it is diagnostic of injury of the lung. As before stated, in external wounds it is frequently seen without wound of the lung, but usually to a limited extent except when the costal pleura is opened, when the air enters through a valve-like opening in the skin, and is then forced back into the cellular tissue. The emphysema in thoracic wounds may be of such an extent as to extend all over the body, rendering the features unrecognizable, the scalp and the palmar and plantar surfaces of the extremities alone being exempt. The looser and more delicate the skin the more distended it becomes; it remains soft and is not discolored, and when touched there is a soft, crackling sensation under the finger as the bubbles of air are driven through the meshes of the areolar tissue. The same thing is met with in the early stages of gangrene when decomposition has begun. Emphysema is not dangerous, except when it is so extensive as to interfere with respiration, or if the air be infected, when it may give rise to cellulitis or erysipelas, or even gangrene. Emphysema generally requires no treatment, as the air is soon absorbed, passing into the blood and through the skin by osmosis. When it is very extensive and

interferes with respiration, the air may be permitted to escape by a number of small punctures in the skin.

All penetrating wounds of the chest are liable to be followed by *pleurisy*, and if the lung be implicated, by *pneumonia*. These traumatic inflammations are also common after fractures of the ribs and severe contusions, but, as a rule, are self-limited and tend to spontaneous cure. If foreign matter finds access to the lung, as in gunshot or other large wounds, decomposition may be excited, causing intense inflammation and abscess, which may open into the bronchi, or into the external wound. The physical signs, when they are not masked by pleuritic effusion or thickening, are similar to those of ordinary croupous pneumonia, and the prognosis depends largely upon the amount of lung involved and the general condition of the patient.

In fractures of the ribs and severe contusions, blood and serum are often poured into the pleural sac, causing *hæmothorax* or *hydrothorax*, and subsequently, by the entrance of air or other foreign substance, the effused material may become purulent, causing *pyothorax* or *empyema*. When this occurs, the suppuration may be ushered in by a violent chill and high fever, or may come on slowly, the effusion gradually increasing and becoming more and more purulent, as when empyema succeeds a serous pleurisy. When an intrathoracic effusion becomes purulent, the first thing to be done is to insure perfect drainage, so that the pus may not be pent up and become decomposed. The serous effusion which accompanies simple fracture, when not absorbed, may readily be removed by aspiration. If from the presence of blood-clots or other causes the contents of the pleural sac cannot be evacuated by the aspirator, the cavity must be drained. If this be done before the pleura has had time to thicken and contract, the lung will expand and become adherent to the chest-walls.

Tumors of the Chest.

Parietal Tumors.—Tumors unconnected with the circulatory system are occasionally met with involving some portion of the thoracic wall. Of these the most common are *exostoses* or *enchondromata*, springing from the ribs or costal cartilages. They may be pedunculated in shape and may attain considerable size.

Mediastinal Tumors.—*Malignant growths* in the thorax are, as a rule, found involving the *mediastinal spaces*, usually assuming the character of a carcinoma or of a sarcoma. From a large number of cases collected and carefully analyzed by Hare, carcinoma appears to be the growth most frequently met with. Malignant growths in this region have certain peculiarities in their development, viz.: not selecting any one or two tissues, but invading whatever comes in their path, following the course of least resistance, and invading the heart, pericardium, and great vessels; nerve filaments become affected, as manifested by various functional derangements which soon end in death, especially when the pneumogastric nerve becomes involved. The œsophagus and trachea are frequently perforated by pressure or become involved in the disease. The diaphragm may be pressed down, caus-

ing distortion of the sternum and ribs, or these may become perforated, allowing the disease to manifest itself externally. Little or no light has been thrown upon the etiology of these growths, which appear to occur more frequently in the male than in the female.

The *symptomatology of mediastinal growths* is by no means clear, as they may be simulated by other conditions, some writers going so far as to state that a diagnosis cannot be made during life; nevertheless, by exclusion, a fairly accurate diagnosis may be arrived at, provided that the presence of the growth is not entirely masked by the occurrence of more prominent symptoms in other parts of the body. In a certain number of cases, pressure on important nerve trunks may bring on a long train of obscure and dangerous symptoms as regards respiration, circulation, deglutition, digestion, and speech.

Growths in the mediastinum are liable to be confounded with aneurisms, abscesses, pleuritic and pericardial effusions, and chronic pneumonia, and can only be differentiated after most thorough and sometimes repeated examination. In pleurisy with effusion, and in pneumonia, there will be dulness on percussion, while in mediastinal carcinoma this sign does not appear unless the growth has encroached upon the chest-wall; even then considerable force must be exercised before any change in the percussion note will be observed. Cachexia rarely appears in mediastinal cancer unless the growth be secondary, so that no dependence should be placed on the absence of this sign. In many instances patients remain fat and well-nourished to the end. Rare cases will be found where sudden and great emaciation may take place by a growth involving the post-mediastinal tissues, and pressing upon and occluding the thoracic duct, thereby preventing the escape of chyle into the circulation. Other rare growths, such as *lymphoma* and *lymphadenoma*, may be found in the mediastinum, but their true character can only be revealed by post-mortem examination.

Treatment of Thoracic Growths.—When the tumors involve the thoracic parietes, and are in a position to be easily attacked, their removal is to be advised, even if the section of several ribs should be found necessary for the purpose. Growths involving the thoracic contents for the most part lie outside of the domain of operative surgery. Nevertheless, dermoid or hydatid cysts may occasionally be removed when found lying immediately below the sternum.

Mediastinal Abscess.

Abscesses affecting the mediastinal spaces are fairly common, and have long been recognized. About twenty-five per cent. of persons suffering from diseases in this region will be found to present lesions of an inflammatory or suppurative character, which appear to be more frequent in the male than in the female, and usually occur in those of a strumous diathesis. Cold, contusions or other injuries in this region of the body, and recent attack of measles or typhoid fever, appear to be predisposing causes. The abscess may be of either the acute or the cold variety. The pain is deep-seated, and pressure-symptoms may simulate those of tumors in this region. In the acute variety all the

symptoms of ordinary inflammation may appear; sometimes the pain is of a pulsating character, similar to that caused by abscess in other parts. In cold abscess the percussion note may vary according to the position of the body.

The *diagnosis* in obscure cases may be cleared up by the introduction of a small aspirator or exploring needle. The *prognosis* is always more favorable than in cases of morbid growth. The acute variety may run its course in three or four days, bursting into the trachea or œsophagus, or may go on for as many weeks.

The *treatment* depends upon the patient's physical condition. If the abscess points externally, it should be freely opened and drainage provided for. If the pus collection is extensively diffused, as in cold abscess, only a portion should be removed at first, lest the sudden relief from intrathoracic pressure should cause fatal syncope. If the abscess does not point on either side of the sternum, but appears to be involving its substance, the trephine may be employed and the abscess evacuated through the opening. A sufficient number of successful cases have been reported to warrant the procedure.

Operations on the Lungs.

Undoubtedly the surgery of the lung is still in its infancy. The experimental researches of Gluck, Wills, Willard, and others, have thrown much light upon the subject, showing that large portions of the lung may be removed in certain cases, and that it is not only possible but judicious to attack abscess cavities in the pulmonary tissue. In some forms of abscess, however, surgical interference is inadmissible; nothing could be hoped for in attacking a lung riddled by numerous tubercular cavities, or by multiple gangrenous foci the result of embolic pyæmia.

Those cases in which surgery may be and has been attempted with a fair degree of success may be thus classified: (1) Well-defined and circumscribed tubercular cavities; (2) cavities resulting from gangrene of the lung; (3) cavities caused by the bursting into the lung of a collection of pus or other irritating matter from without; (4) bronchiectasis resulting from whatever cause, including the presence of a foreign body in the air passages.

The subject of operations on the lung is not entirely new to the minds of surgeons, for Barry[1] in 1726, and still earlier Baglivi in 1714, advocated the opening and draining of pulmonary abscess cavities, saying that the operation might be performed without danger, as adhesions were sure to exist which would tend to shut off the pleural cavity at the point of incision.

The medication of *tubercular cavities* with various antiseptics has been frequently resorted to, the remedy being introduced either through the mouth, or directly, by the medium of a thin canula or hollow needle inserted through the chest-wall. By these procedures little is to be gained except in very small foci which cannot be punctured with any degree of accuracy. Cavities resulting from tuberculous disease, except in rare cases, as following catarrhal pneumonia at or near the

[1] A Treatise on a Consumption of the Lungs, p. 217. Dublin, 1726.

base of the lung, offer but little hope from surgical interference, and as a rule are much better let alone.

Gangrenous cavities resulting from the entrance of a foreign body or a punctured wound, and the similar condition seen as the result of croupous pneumonia where there is no tuberculous element present, constitute decidedly the best class of cases for operative interference, especially if this be not too long delayed.

Bronchiectasis.—Another and totally different variety of pulmonary cavity, due to a dilatation of some part of the bronchial tree, is met with in two forms, the cylindrical and the sacculated. These dilatations may follow the entrance and lodgment of foreign bodies, such as pieces of wood, grass, etc., which find their way into the bronchi from above. Such foreign bodies usually select the right bronchus, which is almost a direct continuation of the main stem, the bifurcation taking place at a point a little below the fourth dorsal spine. The recognition of this fact may be of practical value in attempting to remove obstructions through an opening in the trachea. When foreign bodies have lodged, and it is impossible to remove them, they tend to produce dilatation of the bronchus. These dilatations, unfortunately, are usually multiple; when single (a rare occurrence) they offer a much more favorable field for operative interference. On the other hand, if several adjoining tubes are dilated, but little hope of benefit can be entertained, and an operation should be avoided.

To use the language of Mr. Godlee,[1] the state of our knowledge as to operations upon lung cavities may be summed up in the following words:—

1. Gangrenous cavities should always be sought for, and if possible opened. The prognosis of the operation, if successful, is not bad.
2. The same may be said in regard to abscesses caused by rupture of purulent collections from other parts into the lungs, at least as regards the pulmonary complication.
3. Abscesses connected with foreign bodies must be opened; the body, if not found and if of any size, probably lies near the median line. If possible, these cases should be treated early by tracheotomy and incision.
4. Bronchiectasis, when single, may be cured by operation; when multiple, the results are unfavorable.
5. Tuberculous cavities should not be opened except in cases where the cough is harassing and the cavity single.

The Operation.—The anæsthetic to be employed is preferably chloroform, and it should be administered very slowly, so as to cause as little irritation as possible. The position of the cavity should be accurately determined, and its location verified by the introduction of an aspirating needle, which may be left *in situ* as a subsequent guide. After a free incision, about two inches in length, has been made in as dependent a position as possible, the intercostal space is opened up. If sufficient room is not obtainable, a portion of a rib may be resected, giving better exposure of the lung.

The next step of the operation is the opening of the cavity, which may be done by the introduction of a trocar and canula, and subsequent dilatation with a sinus forceps, or by carrying the point of a Paquelin cautery slowly through the lung tissue, leaving a seared track

[1] Lancet, vol. i., 1887.

behind. The cavity should be thoroughly opened, and, if possible, explored with the finger, and all necrotic tissue should be removed. A long, good-sized drainage tube should be introduced and firmly secured.

In the great majority of cases the lung will be found adherent to the chest-wall, thus obliterating the pleura at the point at which the tube is to be inserted. Should no such adhesion exist, Mr. Godlee advises the preliminary introduction of stitches and the fixation of the lung to the external wound. This procedure is not a very easy one, owing to the constant motion of the lung caused by the act of respiration. After the introduction of stitches no attempt should be made to open the cavity for at least a week, and then the manipulation should be gentle, lest the rather delicate adhesions should be torn asunder. If the pleura should become infected from the escape of purulent matter, it should be treated on the same lines as empyema. As a rule, the bleeding is not troublesome, but if severe hemorrhage should occur, the wound should be packed with gauze.

After-Treatment.—The cavity should be regularly washed out with a mild antiseptic solution, such as carbolized water or Thiersch's fluid, and the tube should be retained until all discharge and expectoration have ceased, as serious relapses have followed its too early withdrawal. Rest, liberal diet, and fresh air will all be factors in insuring an early convalescence.

Hydatid cysts of the lung, though rare in this country, occasionally demand surgical interference. They usually contain daughter-cysts and often attain considerable size, sometimes reaching the proportions of a child's head. They are attended with considerable pain, increased by lying upon the affected side, and are accompanied also with dyspnœa. Unless they suppurate, their course is feverless. Careful observation will reveal undue prominence of the chest-wall and widening of the intercostal spaces, and if not too deeply seated, fluctuation may be detected. Hydatids which primarily have begun in the liver may rupture into the pleura and perforate the diaphragm. The diagnosis should be verified by aspiration, but the withdrawal of the cyst contents will afford but temporary relief. Injections of iodine may in some cases effect a cure, but the most satisfactory results will be obtained by free incision. The steps of the operation are the same as those for the evacuation of abscesses in the lung substance. When the cyst-cavity is reached, Gardner advises the attachment of the cyst-wall to the external wound by means of sutures. Then, with a wound of sufficient size to allow the introduction of one or two fingers by the side of strong catch forceps, the surgeon is able, with a little manipulation, to deliver the mother-cyst entire. During this process many of the daughter-cysts may escape and may be washed out afterward. A large drainage-tube should be introduced, and the wound should be treated in the way already described.

SURGICAL TREATMENT OF PLEURITIC EFFUSIONS.

Collections of fluid in the pleural sac are frequently met with as complications of chest injuries, and also as either primary or secondary

results of pleuritic inflammations. From whatever cause, the effused material will not always partake of the exact characters of either serum or pus. When it is of traumatic origin, the fluid is more or less stained with blood, which in nearly all cases is at first poured into the pleura. When of purely inflammatory origin, the fluid is almost colorless, or of a light straw color, often containing flocculent masses of lymph. The pus in an empyema is not like the healthy pus discharged from an abscess. It is rather puriform, containing masses of unhealthy lymph, often stained with blood and of a very offensive odor, and its escape is not infrequently accompanied by the discharge of offensive gases. The rapidity with which serum may be poured into the chest is remarkable, twenty-four hours being sufficient time to allow the pleural sac to become distended with serum after an acute pleurisy, while equally rapid effusion will often be noticed in the daily discharge from an empyema which has been drained.

On the other hand, collections of fluid may accumulate so quietly and gradually as to cause no uneasiness or distress until the chest-wall has become distended and the lungs compressed. In this class of cases the disease is usually of tubercular origin, and is accompanied with great thickening of the pleura, which is occasionally encrusted with lime salts, transforming it into a cartilaginoid or bone-like substance. A pleuritic effusion may suddenly become purulent by the rupture of a pulmonary or hepatic abscess into the pleural sac.

The rational signs of fluid collections within the pleural sac are dyspnœa, often accompanied with a short grunting sound—the patient usually resting upon the affected side—and rapidity and weakness of the pulse, which is greatly accelerated by the slightest exertion.

The physical signs are enlargement of the affected side, with bulging of the intercostal spaces; a dull percussion note over the seat of effusion, most marked at the base of the chest, continuing up to the level of the fluid collection with the patient in the erect posture, and varying according to changes in his position. If the fluid be sufficiently thin, a sudden jar to the thorax will cause a distinct splash, which may be heard and felt. Displacement of the heart to the right side is frequently noticed if the opposite side is affected. All respiratory sounds are greatly modified or entirely lost; absence of vocal resonance is among the most prominent of the physical signs. The diagnosis may readily be verified by the use of the aspirator or exploring needle. In carrying out this simple operation the strictest antiseptic precautions must be taken, as many serous effusions have become purulent by their neglect.

Treatment.—In dealing with large, serous effusions, too much dependence is often placed upon the power of a diseased pleura to absorb a large quantity of fluid, and in consequence the practitioner is too backward to puncture the chest for these collections, since a large quantity of fluid cannot rest within the pleura without causing serious compression of the lungs, and if on the left side, displacement of the heart and great vessels. For the removal of fluid collections within the pleural cavity the operation of *paracentesis* is performed, either for diagnostic purposes or to relieve the tension, permitting the lung to expand. There is little doubt that many of the unsatisfactory results following this operation are caused by waiting for a diseased and thickened pleura to

absorb a large amount of fluid which has rested for months within its cavity. Consequently, on the removal of the fluid contents, the long compressed lung is unable to recover its former position in relation to the chest-walls, leaving tissues previously accustomed to pressure now entirely free and in a partial vacuum. With this absence of pressure the conditions are more favorable for the escape of serum from the diseased pleura, and reaccumulation rapidly occurs. Many empyemas, too, result from protracted serous collections which have compressed the lung, and the evacuation of which leaves a large pleural cavity which soon becomes infected and purulent.

PARACENTESIS THORACIS.—The operation of paracentesis may be performed in a variety of ways. To Bowditch, of Boston, is due the credit of the first evacuation of serous effusions by suction, a method now universally employed by means of the modern aspirator, in which the fluid is received into a previously prepared vacuum. In the absence of suitable apparatus siphonage may be employed, attaching several yards of rubber tubing to a hollow needle or canula. In default of all mechanical devices, and in extreme cases, the chest-wall may be opened with a bistoury while the patient lies on his side in a warm bath, the pleura being emptied of its serous contents, and the wound closed, while he is still in the submerged position, thus preventing the entrance of air. For the mere purpose of exploration a large hypodermic syringe may be employed. It must be thoroughly cleansed by boiling and soaking in a strong alkaline solution in order to remove all particles of oil, and the needle should be passed through an alcohol flame to insure the removal and destruction of any septic matters which may have collected within it. It is very easy, by means of repeated punctures, to convert a serous effusion into an empyema. The locality selected will usually depend upon the physical signs; the thinnest part of the chest-wall is preferable, and the seventh or eighth intercostal space, near the mid-axillary line, is the point usually selected. The skin should be thoroughly cleansed, and as carefully as for a cutting operation. A local anæsthetic such as the ether spray may be employed if the patient is very nervous, but is rarely necessary. At the place selected, the skin is drawn either up or down, and the point of the aspirating trocar is then carried close to the upper margin of the rib, leaving on its withdrawal a valvular opening through which there is little danger of air entering. The semi-recumbent is the most convenient posture. Syncope, due to the pressure of the effusion, sometimes follows if the patient attempts to lie upon the sound side. A similar result may follow the too rapid withdrawal of the fluid, or the removal of too great a quantity, owing probably to the viscera being unable to accommodate themselves to the altered conditions. The operator should accurately locate the point of proposed puncture, so that the trocar, carefully guarded by the finger, may be carried through the tissues with a firm thrust, thus causing less pain and insuring its passage through the pleura without danger of its penetrating too far, since with a dull trocar, slowly inserted, the costal pleura might be separated from the chest-wall and carried in front of the instrument, which would then fail to reach the cavity. The quantity of fluid to be removed depends upon the conditions of the individual case. No attempt should be made

to remove all the fluid at once if the pulse becomes feeble, if blood is found in the tube, or if the patient becomes weak from coughing; the canula should under these circumstances be immediately removed and the opening closed with gauze and collodion. Not infrequently the flow will suddenly cease, owing to the occlusion of the canula with lymph, which may be disengaged by inserting the blunt rod which is provided for that purpose. Rarely do any serious consequences follow the withdrawal of pleural effusions, except an attack of syncope, which may readily be relieved by placing the patient in the recumbent posture. Perfect rest should be enforced for a number of hours after the operation. Should the lung persistently refuse to expand after repeated tappings, it is hardly worth while to pursue this method of treatment, and tonics and change of air will often prove a more satisfactory means of dealing with these recurrent cases.

The *prognosis* in acute effusions following traumatic pleurisy, in non-tubercular cases, and where the lung expands, is favorable; but if the fluid is purulent, and if after several tappings no improvement is noticed, through drainage of the cavity will usually be the best method to pursue.

DRAINAGE OF THE PLEURAL CAVITY.—This is seldom required, except for empyema. Simple aspiration for the relief of a purulent effusion, except where it is of traumatic origin or in children, is not a very successful operation, and only in those cases in which the compressed lung re-expands on the receding of the fluid and re-occupies its normal position, should it be used. One difficulty in the attempted cure of empyema by aspiration is the inability entirely to empty the pleural sac. After the operation a certain amount of pus is apt to be left, and its absorption really never takes place. The early recognition of purulent change in a pleural effusion is important. In addition to the physical signs denoting fluid in the pleural sac, the presence of pus will be indicated by chills, hectic, and the other phenomena which accompany pus formation. It should always be suspected in children, especially after the eruptive fevers or any serious illness where convalescence is unaccountably delayed, when the patient, instead of improving, begins to fall back. If, under such circumstances, there are any indications of fluid within the pleural sac, its character should immediately be verified by using the exploring syringe. The spontaneous cure of an empyema is a rare occurrence. If left to itself, the pus tends to increase in quantity, and will either rupture externally or into the lung, and be discharged through the bronchus. In a case which came under my care, it burrowed down behind the diaphragm and opened into the intestine. Moullin states that it sometimes follows the course of the psoas muscle and points in the groin. Death may occur suddenly from syncope, due to the rapid escape of the fluid following a rupture; the heart and lung being displaced from prolonged pressure and capable of working only to great disadvantage, the least exertion suddenly turns the scale, and death results from asphyxia due to œdema of the opposite lung, or to pus being discharged into the bronchi in such quantities that it cannot be coughed up. I have seen a case in which the discharge through the bronchi was so profuse that by placing the body in a favorable position—that is, by laying the patient on his sound

side with the hips well elevated and the head low—a continuous stream of pus flowed from the mouth for almost a minute.

Death in empyema may also result from septic absorption or from amyloid degeneration. Sometimes, in children, where the lung has been long compressed, the rather yielding chest-walls will fall in after evacuation of the fluid, encroaching upon the lung and occluding the pleural space, causing a lateral spinal curvature on the affected side with compensating curves above and below. It occasionally happens that the cavity will be occluded by the adhesion of the two pleural surfaces. The unyielding upper chest-walls, however, often fail entirely to contract, leaving a sinus which keeps on discharging a small amount of pus, with little or no inconvenience to the patient, though the prolonged drain in time may tell upon the general health and lead to amyloid degeneration.

Preparatory to the operation for draining an empyema the patient should be in the recumbent position, and as nearly as possible flat on the back. It is more convenient for the surgeon if the patient be rolled over on the sound side, but such a position is apt to embarrass the breathing, especially when the patient is under the influence of an anæsthetic. Chloroform is preferable to ether for these cases, as it induces much less bronchial secretion. The site of incision must be influenced by the physical signs afforded by the collection of matter within the pleural sac. If pus is actually pointing, or if an old sinus exists, that spot should be selected, and, if necessary, a secondary opening may be made elsewhere to insure complete drainage. The usual site, however, is the seventh or eighth interspace in the mid-axillary line in front of the latissimus dorsi muscle. If for any reason a more anterior opening should be decided upon, the fifth or sixth interspace posterior to the costal cartilage may be selected, the chest-walls being thinner here than elsewhere. It is well to raise the arm up to a right angle, as its movement displaces the skin, and the incision should then be made so far above the spot selected that when the arm is brought to the side a direct opening into the thorax will be made, and not a valvular one, the skin wound and the deeper wound corresponding. An incision from one and one-half to three inches in length should be made transversely over the upper margin of the rib, down to the intercostal muscles; then with a firm steel director an opening is made into the cavity beyond. This opening may then be enlarged with the finger or with a pair of sinus forceps. In ordinary cases a drainage-tube as large as the space will admit should be inserted. If for any cause it is found that a second opening is advisable, a steel vesical sound may be introduced through the opening, and its beak made to project at the desired interspace, where it is easily cut down upon with a knife. If two openings are made, the tube (which should be flexible and not too rigid) may be attached to a curved probe, carried through one opening and out of the other, and retained with two safety pins. In this way there is little risk of the tube slipping into the chest or being removed with the dressing, which should be of some absorbing material, such as cotton or oakum, in large loose folds, covered with rubber tissue or wax paper, and retained by the turns of a broad bandage. The dressing should be changed frequently. If from any cause the intercostal artery should be wounded, it should be completely severed and allowed to retract into

its sheath, as much more serious bleeding will result from a punctured than from a severed vessel. Failing in this, pressure by plugging with gauze for a short time will usually suffice to control the bleeding. After the pus has slowly drained away and the cavity has been emptied, it is unnecessary to wash out the pleura with an antiseptic, as absorption ceases and the temperature falls as soon as perfect drainage is established. When, however, the discharge has subsided a little, and especially when the escaping matter is offensive, with a tendency to a nightly rise of temperature, the cavity may be washed out by allowing several gallons of a warm, mild antiseptic solution, such as Thiersch's fluid, to run slowly through it from a vessel held at a slight elevation. Sometimes, especially in operating on cases in which a sinus has existed for some time, permitting partial escape of the fluid, and in which the chest-wall has contracted so that the ribs overlap, as the slates on a roof, thus reducing greatly the size of the interspaces, it may be necessary, in order to obtain a sufficient opening for the tube and to prevent its being compressed, to excise a small portion of one or two ribs. This is easily done after exposure of the rib through the above-described incision. The removal of the periosteum is effected by a periosteotome or curved raspatory, the ribs being steadied by a pair of strong forceps, and they are then divided in two places by a small but firm saw, care being taken that this does not puncture the lung. In children cutting forceps may be employed instead of the saw, but in adults the latter is the preferable instrument, the use of the bone forceps having a tendency to unduly crush and splinter the rib. After the resected portion of the rib has been removed, and the thickened pleura cut away with scissors, the cavity should be gently explored with the finger, as an accurate knowledge may thus be obtained of its extent, and the large masses of curdy material which are often met with may thus easily be detected and extracted. Sometimes, too, the finger will break down adhesions and open up localized cavities which might otherwise have remained unopened for a length of time.

This procedure is not to be advocated in all cases. If the ribs are wide enough apart, as in a well-formed chest, sufficient drainage may be obtained by incising an interspace. It seems wiser to avoid excising a portion of the rib, if possible, when the pus is fetid, as absorption of putrid material is said to be more likely to take place when the bone is cut across; I have, however, never seen any ill results from the procedure. On the other hand, if the ribs offer any interference to drainage, a portion should be immediately removed. The drainage-tube in all cases should be retained as long as any discharge appears; and if, after its removal, there are signs of re-accumulation—such as increased discharge, showing externally, rise of temperature, general discomfort, and thoracic pain—no time should be lost in dilating the sinus and reintroducing it. If this be delayed, the newly formed adhesions will give way and much time will be lost.

THORACOPLASTY: ESTLANDER'S OPERATION.—Not infrequently, in old cases of empyema, the lung is so bound down by adhesions as the result of prolonged compression, that no amount of aid which it may receive by even perfect drainage and the partial collapse of the chest-walls will enable it to expand and allow obliteration of the cavity. This con-

dition is nearly always due to neglect, so that a spontaneous perforation has occurred leaving a thoracic fistula, which discharges at times but a small amount of pus, and at others a much larger amount, and which if uncured, is sure sooner or later to lead to amyloid disease. Even if the cavity is widely opened by the ordinary method, it is impossible for it to heal, since the lung cannot expand from within nor the chest-wall collapse from without. The ribs, acting like parallel hoops, preserve a cavity which every effort on the part of nature fails to close. It is in these cases that the operation of Estlander, or thoracoplasty, has rendered such signal service. It is based on the theory that the unyielding outer walls of the chest-cavity must be made to collapse and meet the lung, and consists in the resection of the ribs which overlie the cavity, the results depending largely upon the completeness with which the two surfaces are brought in apposition and the cavity obliterated. It is almost needless to say that this operation should never be performed except when obliteration of the chest-cavity cannot be obtained in any other way. The state of the heart, of the other lung, and of the kidneys, must also be taken into careful consideration. Phthisis and advanced amyloid degeneration, if distinctly present, are insurmountable objections to operative interference.

The preparation of the patient is the same as for ordinary resection of the ribs. Chloroform is probably the best anæsthetic. The cavity to be treated must be thoroughly explored, if possible with the finger or vesical sound, and its margins accurately mapped out upon the chest with an aniline pencil. It will as a rule be found that the cavity is in the upper and central part of the pleural sac, rather than in its lower portion.

No definite rule can be laid down for all cases, as it is impossible to determine beforehand how many or how much of the ribs will have to be resected. The success of the operation depends here, as it does in operations on other bone cavities, on the removal of the anterior portion of the bony wall, thus permitting the soft tissues to fall in and occlude the exposed space. The ribs usually removed are from the second to the seventh inclusive. The amount removed may vary from one inch to nearly the entire length of the rib.

Various plans and incisions are proposed for exposing the costal walls. Estlander makes an incision along the costal space, and through this wound resects the two adjoining ribs. If six ribs are to be resected, three incisions will be called for. Jacobson advises two or three incisions, two being usually sufficient, and raises several flaps comparatively small in size. Mr. Godlee, one of the highest of English authorities, in his Brompton Lectures, advises a large V-shaped or U-shaped flap composed of all the soft parts. This makes the operation one of considerable severity, as it involves a large wound and possibly much hemorrhage. Gould recommends a longitudinal incision over the central part of the cavity, each rib being exposed in turn and stripped of its periosteum. If a considerable length of rib has to be removed, it is better to cut it away piecemeal. If the cavity extend far back toward the spine, it will be found convenient, after removing the anterior portion of the rib, to remove the posterior part from the inside, peeling the thickened pleura from the bone and applying angulated cutting bone forceps from within the chest, thus simplifying the operation and disturbing

the soft parts less than by any other plan. The hemorrhage attending the operation is considerable, but is easily controlled.

It has been advised, in dealing with large cavities, to attack the ribs from two points: in the usual position, and posteriorly at the inner border of the scapula; thus three or four ribs may be divided in front, and from three to seven behind. The operation is severe in itself, and leaves the patient with an opening through the chest. My own preference, if the cavity is not too extensive, is for the longitudinal incision of Gould, which under ordinary circumstances gives a very perfect exposure. If, on the other hand, the cavity is found to extend over a large space laterally, the exposure made by the incisions of Estlander over the intercostal spaces will prove most satisfactory. Having removed a sufficient length of a sufficient number of ribs, if necessary up to the first —which is never touched on account of its close proximity to the subclavian vessels—as much of the thickened pleura and periosteum is cut away with scissors as will leave a soft, pliant covering to fall in and rest upon the visceral pleura, thus obliterating the cavity. To accomplish this, the cut ends of the ribs must correspond as nearly as possible with the anterior and posterior margins of the space which it is intended to close. It is important to remove enough periosteum, since the great rapidity with which bone is reproduced, if its ensheathing membrane is left, soon puts a stop to the process of contraction, and in some cases a mass of callus has been developed, forming a hard wall as incapable of yielding as the imbricated ribs which it has replaced. The operator has now an opportunity to thoroughly explore the cavity, and it may seem expedient to curette its inner surface with a Volkmann's spoon, to remove septic *débris;* this, however, really does but little good, and often does harm, as the sharp spoon may scrape over the surface of the pericardium, or in close proximity to branches of the pneumogastric or sympathetic nerves. If the cavity should be very large, it may be carefully mopped out with some antiseptic, or a mild antiseptic fluid may be injected with care, this often greatly adding to the comfort of the patient. In my own experience I have never had an unpleasant result from washing out an old empyema; but it must be remembered that a considerable number of cases are on record in which an injection, which may have been frequently repeated without serious consequences, has led to sudden death or to the most alarming symptoms, probably from the sudden increase of pressure within the cavity, caused by a partial closing of the outlet or by the use of too large a tube. The nature of the fluid employed can have had nothing whatever to do with these results, as equally bad results have followed the use of pure water. A large drainage-tube is to be placed in the most dependent portion of the incision, and if necessary a special opening may be made for the tube, when the wound may be closed with sutures. Every provision should be made to insure reaction, as the operation is often accompanied by much shock. The dressing of gauze and cotton is to be retained by a broad bandage carried around the chest.

Paracentesis Pericardii.

Paracentesis pericardii is essentially a modern operation, although it was advocated nearly 180 years ago by Senac. The precision and ac-

curacy with which fluid collections within the pericardium can now be mapped out upon the external surface of the chest, make it a much easier and more precise operation than when it was performed by Larrey. The older writers who have referred to the operation have contented themselves with either advocating or opposing it on purely theoretical grounds.

Opening the pericardial sac may be required for the removal of fluid collections, either of a serous or purulent nature, and usually dependent upon prolonged attacks of illness, generally of a rheumatic origin, or occurring in the later stages of general dropsy. It is worthy of note that of 79 cases of purulent pericarditis reported by West, but one proved fatal as the result of the operation, the trocar in this instance having entered the right ventricle. The immediate result of the operation in nearly every case was good, even if but a small quantity of fluid was removed, the mechanical interference with the heart's action being obviated by the relief from pressure. Death, when it followed, appeared to be entirely the result of the original disease, rather than of the operation or of consequent pericarditis.

Mode of Operation.—If it can be determined with any degree of accuracy that the effusion is of a serous character, and not purulent, its removal by means of the aspirator, observing strict antiseptic precautions, will usually prove the safest and easiest mode of treatment, as the puncture is small, and the entrance of air is readily prevented. If, however, the pericardial fluid is purulent, it is best dealt with as if the case were one of empyema, by free incision down to the sac, which should be lifted with forceps, incised with a pair of blunt-pointed scissors, and dilated with a pair of sinus forceps, allowing the free escape of the fluid. The quantity removed may be very great, and in Dr. West's successful case as much as two quarts were removed without any bad symptoms, or even faintness, but, on the contrary, with immediate relief. The fluid contents of the pericardium might also be evacuated by means of a trocar and canula, and this would probably be a perfectly satisfactory method of treatment, if the question of drainage with a soft-rubber tube and the washing out of the sac with some mild antiseptic solution, such as Thiersch's fluid, were not to be considered. Upon this largely depends the success of the operation.

Trephining of the sternum has been suggested on theoretical grounds as a preliminary to tapping the pericardium, but this procedure is to be deprecated, as it exposes a very vascular bone to the risk of septic absorption and necrosis.

The Place of Puncture.—The point to be selected is usually in the fifth intercostal interspace, about an inch to the left of the sternum, in order to avoid wounding the internal mammary artery which lies about one-half to three-fourths of an inch to its outer border. When the pleura is obliterated and adherent to the pericardium, the operation becomes much simpler, as a spot can be safely selected near the nipple line without danger of opening the pleural sac. The results of the operation should be more favorable than those of empyema, as the walls of the cavity are better adapted to follow and contract on the receding fluid, and thus permit of complete obliteration. The after-treatment of these cases does not differ from the mode of dealing with purulent collections elsewhere.

DISEASES OF THE BREAST.

BY

MAURICE H. RICHARDSON, M.D.,

VISITING SURGEON TO THE MASSACHUSETTS GENERAL HOSPITAL; ASSISTANT PROFESSOR OF ANATOMY, HARVARD MEDICAL SCHOOL.

OUR knowledge of diseases of the mammary gland has been extended chiefly in the line of malignant growths, especially carcinomata. The following article is devoted largely, therefore, to the principal advances made in this direction. A few observations of minor importance have been included upon other topics considered in detail by Professor Annandale in Vol. V. Where neither additions nor corrections have been made, it will be understood that the authorities of to-day differ in no material respect from those whose views were expressed so ably by the author of the article of 1884.

ANATOMY OF THE BREAST.

The boundaries of the breast exceed even the limits previously described by surgeons and anatomists. The importance of an accurate knowledge of the peripheral extension of the glandular tissue is very great, inasmuch as the modern operation for carcinoma requires the removal of the entire gland.

For purposes of description, the breast is divided by S. W. Gross[1] into quadrants by two lines passing through the nipple, one vertical and one horizontal, intersecting each other at right angles. Stiles[2] adds two oblique lines, reaching the circumference of the breast midway between the vertical and horizontal ones. By ascertaining exactly the extremities of these lines, and connecting them, the true boundaries of the breast can be accurately determined. By this method Stiles describes the limits of the breast as follows:—

"The vertical diameter extends from the lower border of the second rib to the sixth costal cartilage at the angle where it begins to sweep upward to the sternum; the horizontal, from a little within the edge of the sternum opposite the fourth rib or interspace to the fifth rib or interspace opposite the mid-axillary line. The one oblique diameter extends from the upper border of the third costal cartilage a little without the sternum downward and outward to the seventh rib a little in front of the mid-axillary line; the other oblique diameter passes

[1] Am. Jour. Med. Sciences, March, 1888.
[2] Edinburgh Med. Journal, June and July, 1892.

from the third rib a little beyond the anterior axillary fold downward and inward to the sixth costal cartilage midway between its angle and its sternal end. The circumference of the organ may be defined by connecting together the extremities of all the diameters. When the arm is elevated, as for an operation, the nipple in a nullipara is placed opposite the fourth rib or interspace, and only about one inch within the axillary border of the pectoralis major, thus showing that the extent to which the breast overlaps the muscle is very considerable. The level of the breasts varies somewhat according to the configuration of the chest—thus tall women generally possess a low bust, while short, broad-chested women have usually a high bust.

"The inner hemisphere rests almost entirely on the pectoralis major; at its lower part it extends beyond the lower edge of this muscle, and slightly overlies the aponeurosis of the external oblique of the abdomen. The outer hemisphere has less simple relations, and must be dealt with in segments. The upper half of its upper quadrant rests on the greater pectoral, on the edge of the lesser pectoral, and, for a slight extent, on the serratus magnus, upon which, and under cover of the pectoralis, it extends upward into the axilla as high as to the third rib. Spence was in the habit of referring to this prolongation as the 'axillary tail' of the mamma. The circumference of this segment crosses the edge of the pectoralis major at the level of the third rib—that is, just where the muscle leaves the chest-wall to form the anterior axillary fold. The lower half of the upper quadrant, and the upper half of the lower quadrant, rest almost entirely on the serratus, with the exception of a small area adjacent to the nipple, which overlies the pectoralis major. The lower half of the lower quadrant has relation to the digitations of the serratus and external oblique which arise from the fifth and sixth ribs, and the part near the nipple lies on the pectoralis major. It will thus be seen that about one-third of the whole mamma lies inferior and external to the axillary border of the pectoralis major. Of this portion the upper half overlies the lower part of the inner wall of the axilla, and is separated from its contents only by the axillary fascia, which is here very fatty, so that the lymphatic glands lying embedded in it appear to be in direct contact with the breast."

Heidenhain, quoted by Dennis,[1] at the German Congress of Surgeons in Berlin, in 1890, pointed out the fact that the ligaments of the breast were often surrounded by projections of the parenchyma of the gland and might contain cancer cells. This is true of the so-called ligaments of Sir Astley Cooper as well as of those which are retro-mammary, and which bind the breast to the fascia.

Stiles has demonstrated the fact that, by treating the breast with nitric acid, the tissues may be so modified that macroscopic changes are produced which permit the constituents of the gland to be seen in marked contrast with each other. This method, described under the operative treatment of mammary cancer, enables one to see the outlying boundaries of the breast, its relations to the skin and deep fascia, and the manner and extent of cancerous infiltrations.

Peripheral processes[2] "springing from the anterior surface of the breast appear as triangular, tooth-like processes with fibrous prolongations ('ligaments' of Cooper) passing from their apices to the corium. The parenchyma is prolonged into these processes, and in thin women reaches almost up to the corium. It follows, therefore, that the surgeon must either sacrifice a large amount of skin, or keep so close to it in dissecting it off the mamma as to run some risk of sloughing." . . .

Posteriorly the microscope "reveals the presence of outlying gland lobules, extending from the corpus mammæ into the retro-mammary tissue, up to and be-

[1] Trans. Am. Surg. Assoc., vol. ix., p. 220 *et seq.* [2] Stiles, loc. cit.

tween the layers of the pectoral fascia. In order, therefore, to remove all the parenchyma, the retro-mammary tissue and pectoral fascia as well as the breast must be carefully dissected off the muscle. Beyond the limits of the parenchyma the stroma of the peripheral processes becomes directly continuous with the connective-tissue framework of the circum-mammary fat." . . .

"The surgical anatomy of the mamma would not be complete without a reference to the retro-mammary tissue and pectoral fascia; indeed, from the surgeon's point of view these structures are no less important than the breast itself, and should be looked upon as part of it. In spare women the corpus mammæ is separated from the subjacent muscles by a thin layer of loosely arranged, delicate connective tissue rich in elastic fibres; the deeper layers are more closely packed to constitute the pectoral fascia proper, which is very thin and gives off processes which penetrate between the fasciculi of the pectoral muscle. The presence in this retro-mammary tissue and pectoral fascia of outlying lobules of the parenchyma has already been referred to. No separation can be made with the knife through this loose areolar tissue without the risk of leaving behind lobules of parenchyma. In obese subjects the retro-mammary tissue is laden with fat, which forms a thick layer separating the corpus mammæ from the subjacent muscles. The fascia in such cases is so thin as scarcely to be recognized."

The course of the lymphatic vessels is of great importance. The evidence upon which our knowledge of the anatomical distribution rests is largely clinical. The main lymph current which sets toward the axilla along the border of the pectoralis major corresponds closely with the course of the arterial supply. Other instances show that lymph drainage extends through the space between the deltoid and pectoral muscles, or directly into the chest through the intercostal spaces; while the immediate communication with the lymphatics of the skin is shown by the frequent occurrence of rapid and extensive superficial invasion known as "*carcinome en cuirasse.*"

Stiles[1] looks upon the mammary lymphatic system as consisting of five sets of vessels which communicate freely with one another:—

"(1) A superficial or cutaneous set, including those of the nipple, areola and surrounding skin; (2) the sub-areolar plexus of Sappey; (3) intra-mammary lymphatics; (4) lymphatics of the circum-mammary fat; (5) retro-mammary lymphatics.

"The lymphatics from the inner part of the mamma accompany the perforating branches of the internal mammary artery to join the sternal glands placed along its trunk. The greater number, however, accompany the mammary branches of the acromio-thoracic, long thoracic, and external mammary branches of the axillary artery to open into the axillary glands. As many as twenty, thirty, or even more may not infrequently be counted when the axilla has been thoroughly cleared out. The reasons for the anatomical underestimation of the number of glands in the axilla are, that some measure not more than one or two millimetres in diameter, while others have undergone such an extensive fatty involution as to resemble closely an ordinary fat lobule."

W. Roger Williams[2] regards the mamma as the homologue of a single sebaceous gland. Polymastism in the human subject occurs in certain definite positions, and corresponds almost invariably with the mammæ of polymastic animals. He has found in fifty cases of fibro-adenoma of the mammary region that seven (14 per cent.) had origi-

[1] Loc. cit. [2] Jour. Anat. and Phys., vol. xxv., pp. 225–304.

nated in supernumerary mammary structures outside normal mammæ. Of 132 cases of cancer he found 13 (9.8 per cent.) which had developed in the same manner, and others which seemed to have done so. He also cites cases of complete absence of both breasts, areolæ, and nipples, in women otherwise well-formed. One case is recorded in which both breasts completely disappeared after lactation had ceased, and reappeared in good condition with the next pregnancy.

Inflammation of the Breast.

Nursing from an inflamed breast is not without danger. Chaillou reports the case of a child nursing from the breast of a primipara affected on the ninth day with lymphangeitis. Death took place with convulsions, coma, paralysis of the lower extremities, and partial paralysis of the left arm. The autopsy showed extensive foci of infection in the brain, spinal cord, and liver. The infecting material was supposed to have been absorbed through the intestines. Nursing from a breast in which the slightest symptoms of lymphangeitis exist is forbidden by most accoucheurs.

Osteochondro-sarcoma of the Breast.

Mr. Battles[1] reports a case of this very rare form of mammary tumor. There had been a small lump on the inner side of the nipple for six years. It had been the size of a pea for two years, and was as large as a hazelnut three years later. When the patient was admitted to the hospital the tumor was the size of an orange, painless, and hard. The nipple was much retracted, but the skin was movable. The tumor was removed and the patient did well.

Clarke[2] reports a case of calcifying chondro-sarcoma of the female breast.

Tuberculosis of the Breast.

Tuberculosis of the mammary gland is a rare affection, though doubtless many cases are overlooked for want of accurate histological diagnosis. Very little has been written on the subject. In 1881 Dubar[3] published the first modern scientific studies in regard to it, and in the same year Le Dentu[4] continued the investigation, to which Olnacker in 1883 added an able paper.[5] The first reference to mammary tuberculosis in English and American books on surgery was made by Roswell Park in the American System of Gyæecology, 1887–88. Since 1887 scattering contributions to our knowledge of this disease have appeared in periodical literature from Orthmann, Hering, Maudry, Roux, Campenon, Lane, Shattock, and others.

An accurate and valuable summary of all the work done in this direc-

[1] Lancet, 1886, vol. i., p. 975.
[2] Transactions Path. Soc. London, 1890.
[3] Des Tubercles de la Mamelle, Thèse. Paris, 1881.
[4] Revue de Chirurgie, 1881, tome i., p. 27.
[5] Archiv f. klin. Chirurgie, 1883, Bd. xxviii., S., 366.

tion has been given by Powers,[1] from whom the following statistics are taken. In the literature of this country but two cases could be found in which an accurate histological diagnosis was made, although several have been reported in which the diagnosis of tuberculosis rested upon the history and gross appearances alone. From the study of all available literature only 35 cases have been collected, of which 34 were in women. The majority occurred during the years of active child-bearing and lactation.

The relative frequency of the disease, until more data are available, is impossible to estimate, although it is safe to say that it is comparatively rare. Bull, of New York, among 185 cases of tumor of the breast, in all of which the growths were examined histologically, found but one of tuberculosis. At the Massachusetts General Hospital no cases have been recorded.

Pathology.—This disease usually manifests itself in the form of cold abscesses and chronic fistulæ. The latter may involve the breast or the axilla. There may be a single large diffuse swelling of the breast, or several small fluctuant areas. The fistulæ present the usual gross appearances of tuberculous tracks. In another form one or more hard nodules may be found in the breast, which on section present the usual appearances of tubercles in different stages of caseation. The axillary glands may be involved, with or without the formation of tubercular abscesses, or they may not be affected at all. Disseminated tubercles may be found in the tissues around the breast.

The *diagnosis* of tuberculosis can be confirmed only by bacteriological demonstration. A family history of tuberculosis, with evidence of the disease in the lungs or elsewhere in association with the local signs in the breast, though obviously very suggestive, is not sufficient proof of the identity of the disease, unless confirmed by a positive histological and bacteriological examination.

Prognosis.—Presumably the general prognosis will depend on the existence of other tubercular foci, and on the extent to which the glands are involved, as well as on the constitutional condition of the individual. Very few of the cases reported have been followed up. Powers[2] traced two cases after radical operation; both patients died of phthisis, one one year, and the other four years, after the operation.

Treatment.—After the diagnosis has been made the only treatment to be considered is thorough excision of the disease both in the breast and in the axilla. Mammary tuberculosis is regarded as a particularly dangerous source of general tubercular infection.

Malignant Degeneration of Benign Tumors.

Gross[3] recommends extirpation of benign tumors on account of their tendency to become malignant, and because tumors of the breast are always a source of anxiety. In one of my cases of diffused fibroma, Dr. Whitney found a spot of carcinoma. Dr. Cabot refers to a similar case. The question of malignancy in connection with benign tumors

[1] Annals of Surgery, 1894, Vol. xx., p. 159. [2] Loc. cit.
[3] Fibroma of Female Breast, Based upon the Study of One Hundred Cases. Med. and Surg. Rep., 1887.

has been discussed by Paget, Hutchinson, and others. Paget says that cancerous disease has never been observed to occur in adenomata of the breast, but Hutchinson,[1] on the other hand, declares that adenoma of the breast, after existing for many years, may serve as a centre for scirrhous growth. This writer therefore questions whether it would not be better to remove all adenomata of the breast, and whether, in a particular case, if the adenoma had been removed any scirrhus would have developed. Patteson[2] describes two cases of adenoma of the breast in children, and, speaking of this variety of tumor and its formation, remarks that while the epithelial proliferation remains intra-cystic, we have the comparatively benign proliferating cystic adenoma; but that if the epithelial development becomes extra-cystic, and crossing the basement membrane extends into the inter-acinous stroma, then we have the infiltrating adenoma, or early stage of adeno-carcinoma, with its rapid local malignancy, etc.

Cystic tumors of the breast may be malignant or benign. The presence of cysts has little bearing, therefore, on the question of diagnosis or prognosis. Butlin[3] reports sixty-six cases of cystic and sixty-six of connective-tissue tumors, nine of carcinoma, and one of adenoma. The solid constituents of these tumors, not their number or their size, influence their history.

Gaillard Thomas describes a method of removing benign tumors without mutilation. He advises their removal because patients with any form of mammary tumor are apt to be apprehensive, nervous, and gloomy. This method is inappropriate for malignant tumors, but has been applied to fibromata, lipomata, cysts, and adenomata, varying in size from that of a hen's egg to that of a duck's egg, or larger. The operation is thus performed: The patient standing erect, and the mamma being completely exposed, a semicircular line is drawn with pen and ink exactly in the fold which is created by the fall of the organ upon the thorax. As soon as it has dried the patient is anæsthetized, and with the bistoury the skin and areolar tissue are cut through, the knife exactly following the ink line until the thoracic muscles are reached. The mamma is now turned up on the clavicle, and the growth is dissected out from below.

Sarcomata of the Breast.

The prognosis after removal of the breast for sarcoma depends upon the class to which the tumor belongs. In some instances the malignancy exceeds that of carcinoma, especially in the melanotic variety. The prognosis is influenced by the invasion of the axillary glands. In the more rapidly growing and malignant forms of sarcoma the lymphatic glands of the axilla have been found early and extensively infected, and in such cases the recurrences have been rapid. At other times there have been remote metastases without perceptible enlargement of the neighboring lymph-glands.

The presence of swollen and tender glands in the axilla in connection with sarcomata of the breast does not necessarily prove that they

[1] Trans. Path. Soc. London, 1888, vol. xxxix.
[2] Jour. of Anat. and Physiol., vol. xxvi., p. 509.
[3] Lancet, July 12, 1884.

are malignant—the glands may be simply irritated. The surgeon should err on the safe side, however, and should clear out the axilla in all such cases.

Gross reports 92 cases.[1] There were 42 local recurrences; in 8 there was reproduction of the tumor with metastasis; in 3, recurrence with all evidences of general dissemination; 4 were characterized by metastases and 2 by presumed metastases without local reproduction—that is, 64.83 per cent. possessed malignant features. Of the reproductions 57.7 per cent. occurred in six months; after twelve months 28.8 per cent. and only 8.8 per cent. of the latter after two years. The latest reproduction occurred after four years. The patient's chances are relatively good after two years. In 156 cases axillary glands were enlarged, and these were occasionally tender in 19, operations with subsequent examination indicating hyperplasia. Before the age of 35 the slow-growing sarcomata will not recur, but rapidly growing sarcomata are very apt to recur, especially the cystic variety. The round-celled growth is the most malignant, but metastases occur with the spindle-celled variety. The operation cures in some cases, and certainly prolongs life. Ninety-one operations show 13.18 per cent. of the patients well after four years. If all recurrences are removed as fast as they appear, suffering is alleviated, life prolonged, visceral contamination averted, and, occasionally, a cure effected. Gross concludes: (1) that sarcomata of the mammary gland, including those of the cystic variety, which is a comparatively benign growth, are neoplasms of decided malignancy; (2) that surgical intervention prolongs life, and frequently results in permanent recovery, and that local reproductions do not militate against final cure, provided that they are freely removed as fast as they appear; (3) that the subjects are absolutely safe from local and general reproduction if four years have elapsed since the last operation.

Gross's statement that sarcoma of the breast does not usually affect the axillary glands, is confirmed by Butlin,[2] only one of whose seven cases of cystic sarcoma had the axillary glands infected. In this case the glands were not removed, and four years afterward the enlargement had subsided completely. Heath[3] regards sarcomata as about as malignant as carcinomata. A soft, rapidly growing tumor of the breast, unaccompanied by enlarged axillary lymphatics, is usually a sarcoma. This consideration does not affect treatment, but has an important bearing on prognosis. There is a great tendency to local recurrence.

TREATMENT.—The treatment of mammary sarcoma by the injection of the products of erysipelas and other micro-organisms, as described by Coley, offers more hope of cure than in carcinomata. This method was very successful in one of my own cases of fibro-sarcoma of the abdominal wall, in which the diagnosis was confirmed by a microscopic examination by Dr. W. F. Whitney. In this instance there was complete disappearance of the growth after a few months' treatment. This method should not, however, be used for growths which can be thoroughly extirpated by the knife. In carcinoma the results are not encouraging. After parenchymatous injections of pyoktanin and other chemicals the results are unpromising. This method I tried repeatedly and thoroughly in a case of rapidly recurring myxo-sarcoma, after the operative treatment had included resection of the ribs and sternum. The cells were found deeply stained, but there had been no perceptible influence upon the growth.

[1] Prognosis of Sarcomata. Trans. Amer. Surg. Association, 1887, vol. v., p. 233.
[2] Lancet, July 12, 1894. [3] Ibid., 1891, vol. i., p. 1027.

Carcinoma of the Breast.

Most of the published work upon mammary tumors has been done in connection with breast cancer, its etiology and operative treatment. In methods of operating the practice of ten years ago has been extremely modified, especially with regard to the extent and completeness of the procedure. A further improvement, common to all operations, has been in the thoroughness of aseptic details—as contrasted with antiseptic—with a marked diminution in the immediate mortality of the operation. The number of permanent cures has increased in an encouraging ratio. Not that the results of the most thorough modern operation afford a large percentage of permanent cures, yet the remark of S. D. Gross, made thirty years ago, is no longer true,—that is, that nothing is more unpromising than surgical interference in cases of breast cancer, though life may be prolonged from six to eighteen months. Not only is life prolonged in recurring cases, but the percentage of permanent cures is very much increased by the completeness of the operations now recommended.

Diagnosis of Mammary Carcinoma.—Unless we follow the rule to operate in all doubtful tumors, it is very desirable to demonstrate by incision the exact nature of the growth. For purposes of exploration, Mixter, of Boston, has devised a small hollow punch, with a circular cutting edge, by means of which a small section of the whole thickness of a tumor may be withdrawn for microscopic examination. Yet the objection common to all simple explorations applies to this method—the probability of overlooking a focus of malignancy in an otherwise benign growth. Tumors of doubtful nature, therefore, especially in women after the age of forty, should be investigated more thoroughly than can be done by a small incision or by an exploratory punch.

The importance of "skin dimpling" in carcinoma of the breast is urged by Tiffany.[1] This symptom may occur when the original focus of disease is so small that attention has not been drawn to it. It is almost pathognomonic of cancer, and is rarely multiple. The dimple is most commonly seen in fibrous carcinoma, and is due to shortening of the connective-tissue processes. This symptom, even with no other signs, justifies immediate operation. Enlarged glands in the axilla are usually regarded as demonstrating the malignancy of breast tumors, but Warren[2] calls attention to the occasional tumors of the sweat glands which may simulate enlarged lymph glands. Stiles[3] speaks of fatty involuted lymph glands, imperceptible through the skin, which, when the axilla has been opened, resemble malignant glands. In stout women these glands resemble fat lobules, and may be overlooked.

Prognosis of Mammary Carcinoma.—The immediate mortality from the modern operation has much diminished in the last decade. The objections formerly raised against extensive dissections no longer rest upon a large death-rate. The mortality as reported from different sources in the past ten years is shown in the following table:—

[1] Maryland Med. Jour., vol. xxvi., p. 309.
[2] Boston Med. and Surg. Jour., July 5, 1894.
[3] Loc. cit., p. 33.

TABLE SHOWING MORTALITY AFTER OPERATIONS FOR CARCINOMA OF THE BREAST.

	No. of Cases.	Mortality Per Cent.
Jefferson College, Philadelphia (previous to 1887)	53	3.7
König (1875–85)	152	7.2
Gross (previous to 1888)	45	4.44
Butlin (collected cases)	605	15.859
Lister	37 (24 axillæ)	5.405
Butlin	40	7.5
Gross (collected cases)	1234	14.24
Terrillon (1880–90)	100	0.
Weir	125	0.
Dennis (previous to 1891)	71	1.408
Gross " " "		10.
Lister (reported by Cheyne; previous to 1891)		8.
Butlin (previous to 1891)		7.
Billroth (before 1888)		23.
Fischer (previous to 1891)		20.
Esmarch " " "		10.
Küster " " "		14.
Billroth (another list)		15.
Id. (still another list)	68	6.
Mass. General Hospital (1877–86)	274	8.3
Do. (1819–71)	290	7.9
Do. (1888–94)	215	1.86
Hans Schmidt	228 (2 males)	10.81
Warren	47	0.
Richardson { (Since 1888) hospital 64—1; (" 1890) private 38—0 }	102	0.98
Halsted	50	0.

Mortality.—The later writers regard the danger of complete extirpation, with dissection of the axilla, as trivial. This great improvement in results is probably due to the aseptic methods now in use, by which the risks of infection are reduced to a minimum, and by which the patient is saved the danger of systemic poisoning from absorption of antiseptic chemicals. According to Dennis the death-rate is three-fold greater after the complete operation than after the incomplete. These figures include all pre-aseptic cases. In 71 operations by Dennis there was but one death, and that resulting from hæmophilia.

Butlin thinks that the completed operation doubles the mortality.

Permanent Cures.—Gross believed that cancer began as a local affection, and that early and thorough excision prolonged life and encouraged the hope of permanent cure. Most writers agree with him. Accepting the three-year period of immunity as the standard by which permanent recoveries are to be judged, the operation up to 1888 definitively cured 11.83 per cent. of cases. In 45 cases of his own, Gross reported 22.5 per cent. of recoveries. Dennis takes a more favorable view, and gives a percentage of 25 cures in his own experience. Schmidt[1] has had permanent recovery in 21.5 per cent.; under a two-year limit 26.4 per cent. In Gross's first series of 100 cases there was not a single permanent recovery.[2] Weir, reporting 20 per cent. cured in 60 traced cases, deems the results of thorough operation encouraging. Terrillon[3] observed no cures in 48 cases of carcinoma with axillary infection. He regards this complication, therefore, as

[1] Deutsch. Ztschr. f. Chir., 1887, Bd. xxvi., S. 139.
[2] Med. News, November 26, 1887. [3] Bull. de Thérapeutique, 1891, p. 385.

necessarily fatal. Warren thinks that we may hope for 20 per cent. of cures in the future; Butlin from 12 to 15 per cent. Less than 2 per cent. of patients who pass the three-year limit have recurrence (Dennis).

With regard to the percentage of complete cures, in the majority of Billroth's cases a simple amputation had been done (Korteweg). The same is true of the cases of Esmarch.

There were cured (Korteweg):—[1]

	Billroth.	Esmarch.	Volkmann.	König.
Of 100 simple cases	10	14	17	36
Of 100 cases with glands	2	7	8	10
Within the years	1867–76	1868–75	1874–78	1875–85

This shows an increase in the number of cures in complicated as well as in simple cases.

Recurrences.—In a very large percentage of cases recurrence takes place even after the most thorough operation. This reappearance of the original disease, according to some writers, depends upon a constitutional rather than a local cause. The weight of authority, however, decidedly favors the local nature and origin of carcinoma. Recurrences are generally regarded, therefore, as the result of incomplete excision. Dennis gives 27 per cent. more recurrences after the incomplete than after the completed operation, and regards 75 per cent., the general average of recurrence, as the result of some defect in operative technique, or of some unreasonable delay.

Gross[2] reported the results in 207 cases of cancer. Of the first 100 cases, 91.75 per cent. were marked by local reproduction, and there was not a single permanent recovery. In these the axilla was not cleared out. In the second series of 107 cases 10 patients died without operation. Local recurrence took place after 52.77 per cent. of the operations, in an average period of seven months. The average life of the thirteen who died with recurrence was 32 months, varying from 2 to 94 months. The average period since the operation upon those who still survived without recurrence, was 3 years and 3 months, varying from 8 years and 3 months to 6 months.

The average interval between the operation and the first obvious recurrence, in 46 cases noted by Williams, was 26 months.[3]

Halsted[4] gives statistics of 50 cases operated on by him at Johns Hopkins Hospital. They are especially noteworthy because of the fact that in only three cases did recurrence take place in the area of operation. Halsted uses the term "local recurrence" to mean recurrence in any part of the region attacked by the knife. "Regionary recurrence" he defines as the multiple recurrences in the skin at a distance from the scar. In 34 cases out of the 50 there was no recurrence whatever, and in these 34 cases 24 patients were living at the time of writing, the periods since the operations varying from three and one-half months to three and one-half years. In only three cases in which recurrence took place was it in the exact area of the wound; in eight cases it was regionary; five patients were not heard from. All of the cases were operated upon in a uniformly thorough manner, the large pectoral muscle

[1] Archiv f. klin. Chirurg., Bd. xxxviii., S. 679.
[2] Med. News, November 26, 1887; Boston Med. and Surg. Jour., vol. cxix., p. 248.
[3] Lancet, January 12, 1889, p. 72.
[4] Annals of Surgery, November, 1894.

being removed entire, and the axillary and supra-clavicular glands being extirpated.

This series of cases is of distinct value as showing the possibility of thoroughly removing cancer as a local disease.

In 62 cases (1877–87) at the Massachusetts General Hospital, the average period before recurrence was 14.2 months. Paget's practice (Barker's statistics) shows 14 months for scirrhous and 7 for medullary cancer. Sibley (Middlesex Hospital statistics) gives 53 months when the growth is removed, 32 when left to itself. Barker—scirrhus let alone, 43 months; operated upon once, 55 months. Medullary cancer —let alone, 20 months; operated upon, 44 months. Stiles has shown that in most of the specimens examined by him the surgeon's knife had not removed the entire organ:—

"Recurrence of the disease after operation is due to the non-removal of small and often microscopic foci of cancer, more or less remote form the main tumor and depending for their origin upon the arrest and growth of cancerous emboli disseminating more or less directly from the primary tumor along the lymphatics. The importance of removing all the retro-mammary tissue, pectoral and axillary fascia, axillary fat and glands, along with the breast in all cases of carcinoma, cannot be too strongly insisted upon or too often repeated. The anastomosis and intersection of the lymphatics are so free that it is impossible to say toward which set of glands the lymph from any given point in the breast will be conveyed. I have seen cancerous lymphatic emboli at the axillary border of the mamma when the tumor was situated in the inner hemisphere, and vice versa. There no is doubt also that the lymphatics of the two breasts communicate to a certain extent through a median anastomosis of both the superficial and retro-mammary lymphatics.

"In carcinomatous breasts the lymphatics may frequently be seen injected, as it were, with cancer cells, so that by a careful study—more especially of the spread of the cancer in the different tissues in and around the breast—one can gain a more satisfactory idea of their structure and arrangement than is to be afforded by chance and unsatisfactory artificial puncture injections.

"The cancer cells invade first the lymph-spaces of the tissue, and, since they probably possess no independent or amœboid movement, their entrance into the lymphatic vessels is more or less accidental. I have repeatedly seen lymphatic vessels containing cancer cells in all the situations in which Langhans has artificially injected them.

"The lymphatics when cancerous are generally filled and distended with cancer cells, which may or may not have invaded their walls and involved the surrounding tissue. Occasionally one may observe a lymphatic of large calibre which is patent, containing only a few cancer cells which appear to have been floating along with the lymph stream. In such a condition the endothelial lining of the lymphatic is very distinct and quite normal. I have never seen any appearances which indicate that the endothelium of cancerous lymphatics in any way participates in the cancerous process.

"The examination of a large number of carcinomatous breasts has afforded a demonstration of lymphatics containing cancerous emboli in one or more of the following situations, viz., in the connective-tissue processes radiating from the tumor into the surrounding breast tissue or circum-mammary fat; in the breast tissue, remote from as well as close to the tumor; in the connective-tissue septa, separating the lobules of the circum-mammary fat; in the so-called 'ligaments of Cooper,' where they often lead to small disseminated cancerous nodules in the corium; in the retro-mammary tissue and pectoral fascia. In the last-named situation they are large, and generally accompany the blood-vessels which pass to and from the deep surface of the mamma."

Mr. Gibbes has demonstrated that carcinomatous cells lie in contact with the stroma; and it is inferred that these cells pass by amœboid movement into the intra-fascicular lymph-spaces, whence the lymphatic capillaries carry them into the nearest gland.

Recurrences are dependent chiefly upon the inadequacy of the operation. The disease in many cases of attempted extirpation is too far advanced for the most wide-reaching operation to be permanently successful. Could such hopeless conditions be recognized beforehand and operation be thereby avoided, the ratio of recurrences would undoubtedly be very much diminished and that of permanent cures correspondingly increased. If those cases in which foci of cancer are known to have been left untouched at the time of operation are excluded, the percentage of recurrences will be greatly lessened. If to these be added the cases in which the outlook is conspicuously unfavorable, even if there be no demonstrable metastasis or untouched nodule, the ratio of recurrences will be still further diminished. Furthermore, if we exclude all cases in which the disease has been known to be present for a long time, and limit, therefore, our observations to cases in which the operation is early and thorough, the prognosis, both as to recurrence and as to permanent cure, will be very much improved.

The recurrence of carcinoma is influenced greatly by the histological character of the disease itself. The more typical the structure, the better the prognosis; the more atypical the structure, the more unfavorable the prognosis.[1]

Permanent cures are certainly influenced unfavorably by the existence of gland complications. When lymph glands are distinctly enlarged and easily felt in the axilla, complete removal of outlying cancer foci is often impossible, for the infected chain may extend beyond reach, or remote infection may already have been established. Moreover, the lymphatic invasion may have taken place by unusual channels, and wandering cells may have been swept into the supra-clavicular lymphatics, into the sternal glands, into the pleuræ, or into the lymph-spaces of the corium; such complications, influencing unavoidably the prognosis, may exist without the slightest sign. Were the latter infections as universal as those of the axillary lymphatics, operations for the permanent cure of breast cancer would be well-nigh hopeless. Even the most favorable reports show that the axilla is involved in the great majority of cases, the glands being so enlarged as to be easily felt either before or after the incision. That the axillary spaces are often infected by the cells of cancer, even when there is no perceptible tumor, cannot be denied, in view of numerous undoubted demonstrations of such complications. In my own experience the rule has been, almost without exception, that in all cases of cancer there is axillary infection, shown in almost every instance by macroscopic inspection, and confirmed by the microscope. In those rare instances in which the glands have seemed normal, malignant foci have been demonstrated by Dr. Whitney, either in the glands themselves or in the free spaces of the axilla.

As a cause of recurrence axillary complications are of great importance. They are of such frequent occurrence that failure to remove the whole axillary contents is usually incompatible with permanent cure.

Küster failed in only 2 out of 117 cases to find unmistakable evidence

[1] Dennis, loc. cit.

of carcinomatous infiltration of the axillary glands, and Mr. Gibbes has proved that such infiltration may be present though it cannot be recognized by ordinary means. Schmidt[1] in 228 cases, including 2 occurring in men, found the glands affected in 97 per cent. The glandular invasion had been recognized before operation in 71.77 per cent.; in 26.25 per cent. the complications were demonstrated only at the time of operation.

These contradictory statistics are due to the greater number of metastases recorded in later reports. (Korteweg.)

	Simple Cases.	With Axillary Involvment.
Billroth (1867-76)	60	90
Esmarch (1868-75)	80	120
Volkmann (1874-78)	25	100
König (1875-85)	25	125

That recurrence takes place first in the neighboring glands is shown by the fact that in 128 autopsies of patients dying from carcinoma of the breast, in 90 per cent. it was found that the patients had had return of the disease in the axilla (Dennis). According to Weir[2] there are axillary complications in 97 per cent. of all cases. The great increase in the ratio of metastasis noted of late years is due to the fact that the earlier observers required more physical evidence of glandular implication, the axilla being left untouched unless a tumor could be distinctly felt. Hence also the high rate of recurrence and the gloomy prognosis of that time. Wyeth[3] reports that of 48 patients operated upon between 1880 and 1890, 42 died and the remaining 6 had recurrences.

In rare instances it must be admitted that the disease appears in the scar of the operation, *de novo*, from irritation, as it might in any other scar from a similar cause, uninfluenced except by a constitutional predisposition.

The influence upon recurrence of the duration of the disease before operation has been much studied. The statistics on this point vary so much with the rapidity of growth and the degree of malignancy, and are so dependent on the patient's own observations, that they are of doubtful value. Korteweg[4] concludes from 322 cases in which the age of the tumor before operation was approximately known, that (1) the more malignant the cancer the earlier it comes to operation; (2) the more malignant the cancer the sooner recurrence leads to death.

Time of operation after recognition of disease.	Duration of Disease Before Operation.	Length of Life After First Operation.
50 cases before end of 3 months	16 months	14 months.
65 " between 3–6 months	23 "	17 "
45 " " 6–12 months	26 "	17 "
57 " a little over 12 months	32 "	20 "
35 " between 12–18 months	42 "	25 "
37 " a little over 24 months	47 "	23 "
33 " over 24 months	58 "	22 "
322 " in all.		

Small tumors, slowly growing, frequently exist for months and even years without exciting apprehension. Such tumors very rarely come to operation until the axilla is seriously infected. Could extensive dissections be made in such cases it is certain that the above table would be much modified.

[1] Deutsche Zeitschrift. f. Chir., 1887. [2] Med. Record, December 31, 1892.
[3] Trans. New York Med. Association, 1891, p. 481. [4] Loc. cit.

Operation for Cancer of the Breast.

The radical treatment for permanent cure of cancer of the breast is aseptic excision of the entire seat of disease. Palliative treatment is devoted to the relief of painful or ulcerating tumors, and to the prolongation of life.

Early and thorough extirpations are indicated in all tumors of the breast which are malignant, doubtful, or benign but troublesome (White). In some cases continuous pain justifies exploration, even if no tumor can be detected. One instance of this kind occurred in my own experience three years ago. A woman of forty complained of persistent pain in the breast. Nothing abnormal could be felt. Exploration followed by microscopic examination proved the presence of a small focus of cancer, which was removed with the infected axillary glands. There has been no recurrence up to the present time.

The variety of cancer influences the question of interference. In far advanced cases of the more malignant and rapidly growing forms, one is not justified in operating; while in cancer of moderate malignancy extirpation may be attempted even in the face of the greatest difficulties.

Cancer, especially of the medullary variety, which has involved rapidly the whole breast, and presumably the peri-mammary tissues, particularly the skin, and which is complicated by obvious axillary infection, does not justify extensive and dangerous dissection nor the hope of permanent cure. Large masses in the axilla, with swelling of the arm, or enlarged supra-clavicular glands; internal symptoms with progressive anæmia; incurable diseases of other organs—all contra-indicate radical operations.

The field of operation must be prepared with the greatest care, for upon this precaution as much as upon the sterilization of the instruments and hands depends the immediate result.

Preparation should be begun twenty-four hours before the operation by shaving the skin, including the axilla. The parts must next be scrubbed thoroughly with a brush in soap and water. A green soap poultice should then be applied, followed by washing in ether or alcohol. Finally a moist corrosive sublimate dressing (1–3000) should be put on and kept in position till the moment of operation, when it is well to wash in a fresh sublimate solution (1–1000). The field, having been irrigated with boiled water and dried with a sterilized towel, is then ready for incision.

Authorities of the present day are practically unanimous in declaring that next to very early operative interference a permanent cure depends upon the thoroughness of the operation. The first consideration, therefore, is so to plan the incision that every vestige of the tumor may be extirpated without regard to the easy approximation of the skin. The closure of the wound thus made must be regarded from the outset as a minor consideration, to be met according to the circumstances of the case. If the enormous and deforming wounds necessary for the removal of an extensive local recurrence had been made in the first instance, it is fair to say that recurrence might have been avoided.

INCISION FOR REMOVAL OF MAMMARY CANCER.—The usual cut has been double and elliptical, made parallel to the fibres of the pectoralis major and including the tumor and the nipple. The numerous recurrences in the scar led S. W. Gross to suggest the ablation of the skin covering the entire gland by a circular incision over the periphery. This method is unnecessary in many cases when immediate healing is desirable, and often makes closure by first intention impossible, without diminishing the liability to recurrence; for if the seat of the tumor be at the breast margin, and if the skin is implicated, a broad space of sound tissue must be assured by making the cut far beyond the mammary circle. If the whole gland is clearly affected, the cut must include the skin beyond the breast by a circular margin at least an inch in diameter, and the parts must be removed regardless of the difficulties of closing the wound. When the nodule is small, non-adherent, and movable, it is unnecessary to make the circular cut of Gross, though it is well to take as much skin as can be spared and yet have effectual approximation. The error should lie rather in the direction of sacrificing too much than too little skin. The principle is "so to plan the incision as best to facilitate the removal of the entire organ, and at the same time of whatever skin is diseased or is at all likely to be so."[1]

Stiles recommends the following method, based upon his anatomical studies of the breast:—

"In a simple case the old elliptical incision, if sufficiently large, is the best incision to employ, so far as the removal of the entire gland is concerned. It should be made parallel to the oblique diameter of the breast, its lower extremity reaching well down below the costal margin close to the ensiform cartilage, and its upper extremity terminating at the outer border of the pectoralis major opposite the third rib. The ellipse should be widest at the nipple, and should there measure at least four inches across.

"If the ellipse includes the whole of the skin over the tumor, the surgeon may at once proceed to reflect the flaps off the breast; but, if the tumor does not fall within the ellipse, the skin over it should be removed by a triangular incision (as recommended by Dr. Joseph Bell, Edinburgh Med. Journal, 1871), the base of which forms part of the ellipse. This plan should be followed not only when the skin is evidently involved, but even when it is freely movable and apparently healthy. It will be obvious that unless such a method be adopted, the ligaments of Cooper, containing lymphatics in direct continuity with those about the tumor area, and therefore liable to contain cancer cells, will be left, and consequently recurrence in the skin or subcutaneous fat will be liable to occur. I believe neglect of this procedure is often responsible for the superficial recurrent nodules which are not infrequently observed in and close to the cicatrix. A combination of these incisions will be most suitable in the majority of cases in which the tumor is peripheral—the result being a T-shaped cicatrix. The lower and outer flap should first be dissected off the breast, keeping as close to the skin as is consistent with the maintenance of its vitality. This dissection should be carried as low down as to the seventh rib in the mid-axillary line. The upper and inner flap is reflected inward beyond the edge of the sternum, and upward almost as high as the clavicle. It is to allow of this free dissection that we recommend that the axillary incision should be made at the same time as the ellipse."

The breast should now be dissected from the pectoralis major, and the fascia of that muscle thoroughly removed. The dissection should be carried far into the periglandular fat under the flaps in all direc-

[1] Stiles, loc. cit.

tions. If the tumor is adherent, the muscle itself should be removed. A knife or instrument that has come in contact with the open surface of the diseased tissue must be laid aside.

The axilla should be opened by an incision along the border of the pectoralis major, and far enough down the arm, along the edge of the biceps, to expose fully the axillary contents. The scar from this cut interferes less with the movements of the arm than that from a cut made directly over the axillary depression, especially if in closing the wound the skin is stitched to the apex of the axillary space. While the axilla is being dissected the breast wound should be covered with dry sterilized gauze, which keeps the parts warm and checks oozing. The excised breast may now be examined by the pathologist, either by making immediate frozen sections or by the method of Stiles, to determine whether the disease has been thoroughly removed. The principle of Stiles's method is as follows:—

1. Mark the position of the breast by a slight incision extending both on the breast and on the skin to be left remaining.
2. Wash the mamma in water until all the blood is removed from its surface, —an important preliminary step, since the nitric acid coagulates and blackens the blood, and thereby obscures the appearances which the method brings out.
3. Submerge in a five-per-cent. aqueous solution of nitric acid.
4. Wash in running water to remove the acid.
5. Place in undiluted methylated spirit.

The rationale of this treatment is that the nitric acid renders all the tissues opaque white, except the fat, through coagulation of their albuminous constituents. By subsequently washing in water, the connective tissue becomes translucent, homogeneous, and somewhat gelatinous. Its consistence in bulk is firm, tough, and india-rubber like. The parenchyma, on the other hand, remains more or less dull, grayish-white, and opaque, due to coagulation of the more highly albuminous epithelial cells. The fat is unaltered. Cancerous tissue behaves in the same way as the parenchyma, and is rendered even denser and more opaque. In very cellular cancers the tissue resembles boiled white of egg, though of a grayish color. The characteristic arrangement of the parenchyma is generally sufficient to distinguish it from the cancerous tissue.

If the examination of the frozen section, or if the tumor thus treated, shows any foci of disease remaining, the suspected parts must be further excised.

The following method of procedure is rapid and effectual in clearing out the axilla. The dissection should be made with a sharp knife along the axillary border of the pectoralis major, as far as its insertion. All bleeding should be checked, and sponging should be made with a constantly renewed clean surface of dry gauze. The loose tissues of the axilla are thus kept free from the usual diffused staining by which all anatomical relations are blurred. Careful attention to this detail will enable the operator to work in a field in which the various structures are sharply defined. Leaving the pectoral border, the fascia which makes the axillary depression should first be incised. This lies directly under the skin, and once freely cut allows the deep structures to be brought immediately and easily into view. The axillary vein should next be exposed and its tributaries tied, with the corresponding branches of the axillary artery. An assistant lifting the elbow upward (and slightly forward if necessary), a good view can be had of the apex of the axilla as far as

the first rib, to which point the dissection can be safely and intelligently carried. Having separated the mass high up in the axilla, along the pectoral border and along the axillary vein, the dissection should proceed downward and backward until the outer border of the latissimus dorsi has been reached, when the whole axillary contents will have been completely separated. In the downward progress the fascia should be removed from the serratus magnus muscle. The intercosto-humeral nerve is generally sacrificed. The subscapular nerves and the external respiratory should not be disturbed unless they are hopelessly entangled in the disease.

If the extent of the disease demands more thorough extirpation, the pectoralis major should be entirely removed, except that portion arising from the clavicle. The muscle should be divided close to its humeral and its thoracic attachments. The dissection of the axillary glands and fat can then be carried up to, or even beyond, the first rib. If necessary, the pectoralis minor may also be removed. Supra-clavicular glands, though regarded by many surgeons as an absolute contra-indication to the completed operation, may be removed after resection of the clavicle, or through an incision in the neck, but so extensive an operation, though justifiable, is not demanded except in extreme cases. Though perhaps unnecessary, these extensive dissections are an error on the safe side. Doubtless in the immediate future the completed operation will require a dissection not only of the axilla, but of the supra-clavicular triangle as well.

Drainage may be dispensed with if the operation has been completely aseptic, and if the wound is perfectly dry. When the breast is ulcerated, inflamed, or otherwise septic, or when for any reason there is abundant oozing, dependent drainage should be established through the posterior flap. The only objection to drainage in suitable cases is the frequent distention of the flaps by an effusion of blood, which may take place even in perfectly dry wounds. Wounds distended by blood require more time for convalescence, and are more liable to become septic.

The wound may be united by continuous or by interrupted sutures of silk or of silkworm gut. When the wound cannot be closed, immediate skin grafting may be practised, or spontaneous closure by granulations may be awaited.

The whole operation should be strictly aseptic rather than antiseptic. Nothing should come in contact with the wound that is not sterile and innocuous. Antiseptics retard immediate agglutination of surfaces; they make drainage necessary, and not infrequently produce symptoms of constitutional absorption. The low mortality of the modern completed operation is due to the strict observance of aseptic details.

Treatment of Malignant Tumors of the Breast by Local Applications.

Paget,[1] after calling attention to the likeness existing between cancers and innocent tumors on the one hand, and specific and micro-parasitic diseases on the other, expresses a belief that we shall eventually find

[1] Lancet, November 19, 1888.

that there is some micro-parasite which is essential to the production of cancer. Furthermore, he considers cancer as allied to syphilis, tuberculosis, glanders, leprosy, and actinomycosis. He believes that we may reasonably anticipate as effective a remedy for cancer as mercury and quinine have proved for syphilis and malaria.

Injections of Methyl Violet in the Treatment of Cancer.—Prof. von Mosetig-Moorhof [1] uses solutions of methyl violet or pyoktanin (1–1000, 1–500, 1–3000) injected into the growth until the pathological tissue is thoroughly impregnated with the coloring fluid. The diseased tissue is alone affected. Enclosed tumors do not disintegrate, but undergo a retrograde metamorphosis and contract. Open tumors secrete profusely and diminish in size more rapidly. There have been no cures from this practice, but marked diminution in size has been observed.

Idelson, of Berne, in a review of the literature on this subject [2] says that the value or efficacy of pyoktanin in the cure of epithelioma is not yet established, and that the successes are outnumbered by the failures.

The evidence is not conclusive that this method exerts a retarding influence upon the development of cellular growth. In one instance a case of very rapidly growing myxo-sarcoma was treated for a long time by daily injections of pyoktanin. The solution permeated the structure in all directions. A microscopic examination of the scrapings after the use of the remedy was made by Dr. Whitney, who reported that the cells were distinctly invaded by the solution. Repeated observations convinced me that this method had no effect whatever in retarding the development of the disease. Though having apparently so little effect upon the luxurious growths sometimes seen in sarcomata, there is considerable evidence that in the slower development seen in some phases of cancer this method is worth trying. In no event, however, should dependence be placed upon injections unless free extirpation is impracticable.

Escharotics.—Of all escharotics, chloride-of-zinc solution is the most satisfactory. In the case just alluded to, in which pyoktanin failed, the daily application for a short time of a fifty-per-cent. solution of chloride of zinc was attended by very favorable results. In this case the tissues of the thorax had become exposed to a diameter of about eight inches. From the base of this expanse luxuriant masses of disease sprang. A daily application, for a few moments, of gauze wrung out in a fifty-per-cent. solution of chloride of zinc was followed by a local destruction of the growth, though a permanent cure was not accomplished in this manner. The use of escharotics, however, is very unsatisfactory and never should be resorted to except when excision is impracticable.

Treatment by the Injection of the Streptococcus of Erysipelas or Its Products.—The germ theory of cancer has suggested the inoculation of micro-organisms, or their products, for the purpose of combating the original disease. It was observed many years ago that the frequent occurrence of erysipelas was followed by beneficial results in the convalescence from cancer.

Feilchenfeld [3] reports a case of inoculation with erysipelas, fatal in

[1] Wien. med. Presse, 1891, No. 32, S. 6.
[2] Annals of Surgery, 1892, vol. xvi., p. 88.
[3] Arch. f. klin. Chir., 1888, Bd. xxxviii., S. 834.

four days. In Holst's case there was temporary improvement, but the growth began again in a few months.[1]

Coley[2] has recently treated cancer of the breast in this manner, but with less promising results than in sarcoma. Thus far he has had no complete cures, but in five out of six cases there has been a marked improvement. This method should be applied only in cases which cannot be treated by excision. On account of the great dangers incident to the injection of the living germs, the sterile products of their growth should alone be used.

[1] Centralbl. f. Bakteriol., 1888, Bd. iii., S. 393.
[2] Annals of Surgery, vol. xiv., No. 3.

INJURIES AND DISEASES OF THE ABDOMEN.

BY

ALBERT VANDER VEER, A.M., M.D., PH.D.,

PROFESSOR OF DIDACTIC, ABDOMINAL, AND CLINICAL SURGERY IN THE ALBANY MEDICAL COLLEGE; SURGEON TO THE ALBANY HOSPITAL, ETC., ETC.

A REVISION of the admirable and exhaustive chapter on abdominal diseases and injuries, written for the International Encyclopedia of Surgery by Mr. Henry Morris, can be nothing more than a digest of the advances made in the last decade. The original article is a model of intelligent research, completeness in detail, and rare surgical acumen. Few additions will be made to the subjects discussed, and they are such as have been developed in more recent years.

A comparison between the management of the surgical affections found within the abdomen, a decade ago and at the present time, will show a material advancement. This condition can be attributed to no single factor. The increased knowledge of pathological conditions, the more accurate diagnosis resulting from greater experience, and the improvements in the technique are each sources of material advantage. For example: In appendicitis, the anatomical relations of the appendix, the precise pathological condition, and the diagnosis, were all involved in more or less uncertainty until very recently. What is true of appendicitis is equally true of pelvic abscess, extra-uterine pregnancy, and diseases of the liver and biliary ducts. The studies of the endo-enteric organisms and their relations to peritoneal inflammation have led to important discoveries, which promise much in the way of making clear many things that gave the surgeon great concern in the early days of abdominal surgery.

The technique in abdominal section, taken in its broadest sense, has undergone many changes. Processes have become less involved and mysterious. The speculative has largely gone out from abdominal surgery. The involved processes in the preparation of the operating room, of the patient, of the sponges, sutures, ligatures, and dressings, prescribed by antiseptic surgery, have given way to the more simple and rational methods of aseptic surgery. Simplicity is aimed at in every possible direction. Experimental surgery has been of great assistance in establishing surgical procedures in abdominal surgery. The use of inflation of hydrogen-gas for diagnostic purposes in penetrating wounds of the intestine, and in establishing the relations of tumors to other viscera, has been of great assistance. Intestinal anastomosis by plates of decalcified bone, rawhide, or potato, as well as by the Murphy

button, is an important time-saving appliance developed through experimentation on the lower animals.

Abdominal surgery, for the most part, has passed the transitional and speculative epoch in the last decade. It is now in position to assume its relation to the general system of surgery, as have amputations, ligations, and excisions. The natural effect of these propitious influences has been to increase the confidence of the surgeon, and conditions are now attacked with boldness and success which but a few years ago were only palliated for a short time until the patient died.

PERITONITIS.

When facts in any department of knowledge become clearly established and adequate, simplicity in classification is a natural sequence. The application of the foregoing statement to later conceptions of peritonitis is a striking illustration of its truth. Idiopathic peritonitis has practically been abolished from medical nomenclature, and for a good reason: it is indefinite and inaccurate. We are asked, indirectly to be sure, to accept the truthfulness of the antiquated notion that a specific inflammation may arise of itself. Clinical experience and experimental investigation both establish, almost if not quite beyond controversy, that peritonitis can only arise through bacteriological infection. That exposure to cold, strains, and contusions of the abdominal walls and viscera may be associated with a succeeding peritonitis cannot be disputed, but only in a contributing way. Irritation results in decreasing the resisting power to bacteriological invasion. An injured intestine may let out through its coats pathogenic bacteria, which could not pass through a normal intestinal wall.

A serious skepticism may be maintained regarding peritonitis induced by the injection of irritants like trypsin and croton oil into the peritoneum. While the results may show pathological conditions, in many cases similar to the conditions found in a bacteriologically induced peritonitis, yet they are not identical. The results of experimentation are often untrustworthy because the experiments have not been carried to a final conclusion. It is difficult to understand why a special etiology is required for peritoneal inflammation. It being granted that peritonitis is necessarily an inflammation induced by bacteriological infection, its varieties must be determined from another standpoint than that of etiology. Pathological conditions constitute the proper basis for the differentiation of the varieties of a disease. From conditions found in operations, and at the post-mortem table, peritonitis is either septic, suppurative, plastic, or tubercular, the character of the exudate determining the variety in each case.

A great variety of pathogenic bacteria have been found in the exudation of peritonitis—Streptococcus pyogenes and erysipelatis, Staphylococcus pyogenes, aureus, and albus, Diplococcus pneumoniæ, Bacillus tuberculosis, Bacillus pyocyaneus, Bacillus communis coli—and a definite but variable number of each variety are required to induce inflammatory reaction. For example: experimentation has shown that one minim of a pure culture of a given form of bacterium produces no reaction when introduced into the peritoneum of a rabbit. Five minims

of the same culture introduced at the same point, under identical conditions, produce a localized plastic peritonitis followed by recovery. Ten minims introduced into the abdomen of another rabbit, under proper control, are followed by death in thirty hours from septic peritonitis. Again, different varieties of bacteria exhibit widely varying degrees of virulence. The organisms found in ordinary suppurative processes are by far less virulent than the Diplococcus pneumoniæ or the Bacillus communis coli.

PATHOLOGY OF PERITONITIS.—The conditions exhibit decided differences in each variety. If an examination be made within a few hours from the onset of a *septic peritonitis*, the division of the parietal peritoneum will be followed by an outpouring of the exudation. A careful examination of this fluid, usually brownish, opaque, and foul-smelling, will demonstrate the presence of both red and white blood-corpuscles, granular detritus, flocculent lymph, and innumerable bacteria. No matting together by plastic lymph of adjacent peritoneal surfaces will be found. The peritoneum, both parietal and visceral, in every portion of the abdominal cavity, is deeply injected, and may show numerous points where hemorrhages have occurred between the serous membrane and underlying tissues. The peritoneum soon loses its glistening appearance. The vessels (lymphatics) of the mesentery are engorged. Following very closely, the lymphatic glands are swollen, the liver, spleen, and kidneys are seriously congested. If the patient can withstand the continued auto-administration of ptomaines for a few hours longer, there may appear in the spleen or liver patches of necrosis. In the last stages the exudation may be more nearly purulent.

The *plastic variety of peritonitis* is always a localized condition, at least in the beginning. The exudate is fibrinous or fibro-plastic, never serous. The best examples of plastic peritonitis are found associated with gonorrhœal infection of the uterine appendages, or in a portion of the cases of appendicitis. The process of matting of adjacent structures may remain circumscribed or spread by continuity. In cases of chronic peritonitis, it may be impossible to isolate a single organ without greatly endangering the integrity of adjacent structures. Bands occluding the intestines may occur, and may induce intestinal obstruction.

Pure *suppurative peritonitis* as a primary condition does not occur. It is always secondary to either one or the other variety, usually the plastic. When in the course of a plastic peritonitis the intensity of the inflammation is such that the exudate becomes necrotic, abscesses develop about these centres of necrosis, and increase in size from an extension of the primary process. Abscess may develop, on the other hand, from perforations in viscera—the intestine, appendix, gall-bladder, or Fallopian tube. Suppurative peritonitis is consequently found as a sequence of inflammatory changes in the uterine appendages, vermiform appendix, or gall bladder, and in peritonitis following delivery.

That the exudation associated with a purely septic peritonitis is ever distinctly purulent, in the common acceptance of that term, is open to very grave doubt. If a fluid, which may be properly termed pus, is ever found in septic peritonitis, it is only at a very late stage of the disease. The two conditions, plastic and septic peritonitis, occur together under certain conditions. A localized plastic peritonitis has as-

sociated with it abscess, which, gradually distending, finally ruptures its wall of lymph, and the contents enter the general peritoneum. A septic peritonitis, naturally from the character of the infection, is induced, and proceeds rapidly to a fatal termination. In this way many neglected cases of pyosalpingitis, ovarian abscess, and appendicitis terminate fatally.

Tubercular peritonitis is usually a low grade of inflammation induced by the deposit of tubercle on the peritoneum. It is observed in two varieties: one is associated with a serous, and the other with a plastic exudation—the exudate in either case resulting from the presence of tubercle on the membrane.

SYMPTOMS OF PERITONITIS.—In general, the symptoms of peritonitis are characteristic and do not often lead to a mistaken diagnosis. Many evidences of the onset of the disease are so commingled with those of the etiological condition that isolation and analysis are quite impossible, or are capable of serious misconceptions. This is especially true of appendicitis.

Pain is generally, and correctly, regarded as an important symptom of peritonitis, yet pain is not necessarily present in the most virulent attacks of the septic variety. This fact is confirmed by many careful observers. Again, there is no characteristic pain either in kind or position. Patients describe it as sharp or dull, steady or lancinating, and of all degrees of severity. They often describe it as a pain such as they have never felt before, and as one which gives them an idea that something very serious or fatal will result from it. The pain of peritonitis may be simulated by that of appendicitis, perihepatitis, enteritis, pancreatitis, biliary or renal colic, obstruction of the bowels, intestinal colic, gastralgia, and influenza, and can only be differentiated by a most careful estimate of the value of the accompanying symptoms. The pain of peritonitis is never relieved by pressure, and is accompanied by a tenderness more or less exquisite. *Nausea and vomiting* are often early and very serious symptoms. First the contents of the stomach and duodenum are evacuated, and then, particularly in septic cases, large quantities of a spinach-green or blackish, flocculent fluid. Where there is intestinal obstruction, either organic or paralytic, the vomited material becomes stercoraceous in character. Vomiting of either of the last varieties must always be looked upon as of very serious importance. *Abdominal distention* is a third important symptom. In septic peritonitis it comes on early and very rapidly. In plastic peritonitis, on the other hand, it is a late symptom and an indication of beginning organic intestinal obstruction.

There are no more important symptoms of peritonitis than those found in the circulation. While there is nothing in the *pulse* which may be described as pathognomonic of peritoneal inflammation, yet there are few experienced observers who will not be able to establish a presumptive diagnosis from the pulse alone. The pulse is rapid—from 100 to 160—small, compressible, and very seldom dicrotic. It falls away from the finger, and may intermit. If there is much abdominal distention the right heart and veins are distended and the skin cyanotic. The *temperature curve* of peritonitis shows nothing characteristic in septic peritonitis; it may continue below normal until death occurs, and

rarely rises above 102° F., though occasionally, after reaction has followed perforation, a distinct rise is observed to 104° F. or higher. In plastic peritonitis the temperature remains between normal and 101°, unless suppuration occurs, when a rigor and subsequent elevation of temperature are seen in many cases. As an element in diagnosis temperature assumes a negative position. Much has been written of the *physiognomy* of patients with peritonitis. The facial expression gives at once the impression of a serious illness. It is pinched, drawn, and anxious. The nose is more pointed, and the lines are lengthened, particularly at the sides of the face. The *extremities* are cold and cyanotic, and are often covered by a clammy perspiration; the legs are often, although not invariably, flexed. The *tongue* shows, as a rule, no especial changes in peritonitis.

Physical examination reveals, in addition to the symptoms already mentioned, several others of importance. In plastic peritonitis there is usually *localized tenderness*, associated with *dullness* over the affected area. *Palpation* shows a definable tumor. *Auscultation*—a valuable adjunct—gives evidences of gurgling and of peristaltic action in the intestine. In septic peritonitis there is often no part of the abdomen dull, unless the exudation is abundant. There is no peristaltic action. The intestinal coats are paralyzed. The most important physical sign of peritonitis is, beyond doubt, the peculiar *resistance* given to the palpating hand by the contracting abdominal muscles. It has been variously described—like a deal board under the skin expresses it most closely. To my mind, when this peculiar resistance is not present the diagnosis of peritonitis may be regarded with suspicion. *Constipation* is the common condition in peritonitis, though diarrhœa may rarely be present in the suppurative variety.

DIAGNOSIS OF PERITONITIS.—There are many conditions which must be excluded before a diagnosis of peritonitis can be established. Several have already been mentioned. Typhoid fever, intestinal intoxication, and ptomaine poisoning are to be added. A critical study and proper estimation of the value of the different symptoms will usually prevent error in diagnosis. Tubercular peritonitis is properly considered in connection with dropsies and can receive no extended notice here.

PROGNOSIS OF PERITONITIS.—The prognosis of septic peritonitis is exceedingly grave. Many writers are firmly of the conviction that all who suffer from it die under all forms of treatment, surgical or medical, but I myself believe that in many instances, with an early laparotomy, proper irrigation, and drainage, recovery may confidently be expected, although it is extremely difficult or impossible to say that any particular case is likely to terminate favorably. In plastic peritonitis, however, the prognosis is much more promising. If the inflammation runs a mild course, the prognosis, under purely expectant treatment, is good. When it assumes a graver type, becoming suppurative, surgical intervention has been able to save a very large percentage of cases. Organic intestinal obstruction is often a dangerous complication.

TREATMENT OF PERITONITIS.—In theory, the treatment of peritonitis

is established, but at the bedside there arise many conditions of which the management is debatable. There is yet widely disseminated in the mind of the profession a confidence in the so-called *opium treatment* of peritonitis. This condition of affairs does not admit of explanation. After many years' experience in both hospital and private practice I have yet to see the utility of the so-called opium treatment. I have seen it mask symptoms, and establish in the minds of the physicians and of the patient's friends a feeling of hopefulness, quickly dashed to the ground by the patient's sudden death. It is very difficult to define the proper position of opium or its alkaloids in the treatment of peritonitis. The indications for its exhibition, as they appear in the light of recent practice, will be given in detail at the proper place. The treatment by hydragogue *cathartics*, chiefly saline, is subject to certain limitations. There can be no doubt, however, that this plan, so earnestly advocated by Mr. Lawson Tait, is preferable to the indiscriminate use of opium.[1]

The matter of the *prophylactic treatment* can only enter into the management of peritonitis following operations. Surgeons fully appreciate the importance of the condition of the intestinal canal in abdominal surgery. Where it is not imperative to operate immediately, the complete evacuation of the bowels forms a distinct indication for preliminary treatment. Tendencies to intestinal distention from indigestion should always be corrected, as far as possible, by suitable diet and medication. The broad subject of the aseptic technique in abdominal surgery cannot be entered upon in detail, but it can only be said that great experience and care are required in the organization of such operations. However careful the surgeon may be, now and then, from defects or omissions in technique, from environment, or from serious inherent difficulties of the operation, peritonitis will follow. It should not occur often, it will occur occasionally. Post-operative peritonitis is, as a rule, septic and virulent, and its treatment must be active and immediate. Given a case of peritonitis, diffuse and septic in character, what shall be done? There is but one course that offers to the patient any hope of recovery, and that is *abdominal section* performed at once. Unless there are special indications, the median incision will serve the operator best. If due to perforation of the stomach, intestine, or appendix, these conditions must first receive proper treatment by suture or excision. The abdomen should be flushed with sterile, normal salt solution, 6–1000, at a temperature of 105° to 110° F.[2] The addition of two per cent. of alcohol to the irrigating fluid is advantageous in relieving shock. Several gallons may often be used with advantage. The fluid should return clear before the flushing is discontinued. A full-

[1] [The Editor feels compelled to express his dissent from this sweeping condemnation of the use of opium in peritoneal inflammation. For his own part he looks upon this drug as the most valuable single remedy for peritonitis, and is confident that by its systematic use, in connection with local depletion by leeches, he has saved the lives of many patients suffering from inflammation of the peritoneum who without it would have perished. By its systematic use is meant not the exhibition of an occasional dose as an anodyne, but continuous administration in the way recommended by the late Dr. Alonzo Clark—one grain of solid opium, or its equivalent, every hour, day and night, until the patient's respirations are brought down to twelve in the minute. As for the "masking of symptoms," the only symptom thus affected is pain, and even if the absence of pain were an evil, which it is not, it would be more than compensated for by the increased facility given for physical examination by percussion and palpation.]

[2] Thorough sponging with gauze will sometimes answer without flushing.

sized Keith's drainage tube should be passed into the pelvis, and this may be supplemented by strips of iodoform gauze leading from the abdominal wound into each flank. The wound should be only partly closed with silkworm-gut sutures, although others may be introduced, to be tied after the removal of the drainage.

Where there is a paralytic condition of the intestinal walls due to hyperdistention, the question of *enterotomy* and evacuation through a large trocar, or of the establishment of a *fæcal fistula*, may arise. Where the general condition of the patient will admit of it, this procedure will, in many cases, be of much assistance. No definite indications can be laid down for the employment of either method. In general, they may be said to be most useful in cases where both cathartics by the mouth and enemata have failed to bring about movements of the bowels before operations have been undertaken.

During operations for septic peritonitis every effort must be made to prevent shock. The patient should receive before the operation a stimulating enema of beef juice and whiskey, and should be warmly wrapped in flannels, with hot-water bottles so placed that the temperature may be maintained. The operation must be completed with all the dispatch possible to good surgery. It is best to remove the patient to a hospital, whenever possible. The fatigue of removal in an ambulance is more than compensated by the advantage of trained assistants and conveniences for the operation.

After-treatment of Septic Peritonitis.—Every effort must be made to establish reaction as soon as possible. External warmth and free stimulation are indicated. The hypodermic exhibition of morphine and atropine may be demanded, to relieve pain, but great caution is required in their employment. If the reaction is satisfactory, the Leiter cold coil or ice bags may be applied to the abdomen over light, aseptic dressings. Vomiting, when persistent, is relieved by the discontinuance of all fluids by the mouth for a few hours. A very happy effect has been induced by the administration of the following:—

℞ Cocain. hydrochlorat. ..... gr. ij.
Hydrarg. chlorid. mitis ..... gr. ij.
Cerii oxalat. ..... gr. xvi.
M. Ft. chart. no. viii. Sig. A powder every hour or two.

Occasionally champagne can be retained when the stomach rejects all else. If found agreeable it may be given freely. Koumyss, Matzoon, or a reliable preparation of liquid peptonoids, may be given after twenty-four hours. When the powders above mentioned are not sufficient to produce a movement, stimulating enemata containing glycerin or turpentine should be given. It may be necessary to introduce the enema high in the colon by means of a long rectal tube, and a saturated solution of Epsom salt may occasionally be used in this way with great advantage.

The care of the *drainage tube* is of great importance; for the first twelve hours, the wick of iodoform gauze within the glass drainage tube need not be disturbed. Afterwards it should be changed at frequent intervals. The strips of gauze extending laterally into the flanks may be removed after two days, and the remaining sutures tied. The glass drainage tube will remain somewhat longer.

It may be said that if the patient is in a favorable general condition,

and has had satisfactory motions on the third day after the operation, the chances of ultimate recovery are good.

Treatment of Plastic Peritonitis.—In plastic peritonitis, where the inflammatory reaction is not severe, medical treatment by laxatives and enemata, together with the administration of phenacetin and codeine for pain, are often sufficient. Rest in bed, with ice to the abdomen, is a necessary adjunct to the outlined treatment. Resolution during the stage of decadence is often hastened by blisters and hot fomentations.

When suppuration occurs and either single or multiple abscess is formed, early surgical interference is necessary, but must be undertaken with great care. Every effort must be made to enter the abscess without bringing about an infection of the general peritoneum. This can be readily enough accomplished in many cases of pelvic peritonitis and appendicitis. Conditions occur, however, in which it is impossible to reach and evacuate intraperitoneal abscesses without subjecting the patient to the dangers of a general septic infection. Here the method of opening the abscess in two stages, after the method employed by Sonnenburg, is useful. First, an exploratory incision is made, establishing all the anatomical relations of the abscess, and then the wound is plugged with iodoform gauze. After firm adhesions have been established, the abscess cavity is opened and drained. The after-treatment calls for no especial description.

Obstruction of the bowels is not an unusual complication of plastic peritonitis. Bands of lymph cause either direct occlusion or acute flexure. When the process is not too extensive these adhesions can be broken up by abdominal section. On the other hand, when the plastic exudation is widely distributed, or is associated with large pus cavities, enterostomy, with the making of a fæcal fistula, is at once more conservative and offers better chances for ultimate recovery.

The recent statistics of König and others have placed incision and drainage in *tubercular peritonitis* upon undisputed ground. In my own experience this plan of treatment is followed by cure in most cases. Lately there has accumulated much evidence in favor of the simple introduction into the peritoneal cavity of iodoform in some form or other, such as the dry powder, or the iodoform-glycerin mixture.

Appendicitis.

The subject of inflammation in the right inguinal region, its pathology and treatment, has undergone a very radical change, and from the maze of unmeaning terms by which it was formerly designated, such as typhlitis, perityphlitis and paratyphlitis, intraperitoneal and extraperitoneal abscess, etc., we are at last relieved through the very thorough investigations that have been made by Fitz and others, and we now have the true term, *appendicitis*, indicating the pathological condition that really exists.

It is possible that there may be a condition of typhlitis owing to the impaction of fæces within the cæcum, and that it may perhaps lead to ulceration of this portion of the large intestine; but though it has been observed in a few cases, it is an exceedingly rare affection.

Appendicitis, or inflammation of the appendix vermiformis, presents

a variety of conditions as regards etiology. It is by far most prevalent between the ages of six and twenty, and in many cases is undoubtedly due to slight injuries, errors in diet, especially over-indulgence in improper articles of food, or exposure to cold, and not, as has heretofore been frequently supposed, to the fact of foreign bodies lodging in the appendix.

With few exceptions the vermiform appendix is intraperitoneal, and hence appendicitis is almost always an intraperitoneal inflammation. Unless in these very exceptional cases, it is impossible to touch or reach the vermiform appendix without introducing a finger into the peritoneal cavity.

SYMPTOMS AND MORBID ANATOMY.—The symptoms in *acute perforative appendicitis* are very rapid in their development; sharp pain is felt, accompanied by nausea and immediate prostration, and the pulse is rapid, reaching 120 within a few hours. When a patient becomes suddenly and dangerously ill, with symptoms of general peritonitis, the diagnosis of acute perforating appendicitis may be ventured with almost absolute correctness, even though many of the local symptoms are absent. The conditions of collapse are present, and the patient sometimes dies within twenty-four or thirty-six hours from the onset of the disease, seldom living longer than the third or fifth day, except there be surgical interference.

When we consider the anatomical structure of the appendix, the method of invasion of the mucous membrane, and the subsequent lymphatic and circulatory phenomena, they are found to be identical with similar processes occurring elsewhere in the body. Acute, perforating, fulminating appendicitis presents the most serious type of the disease, and one attended by the gravest dangers to life.

The conditions found at operation, however early undertaken, are usually as follows: The appendix itself is either uniformly dark in color, or mottled; its peritoneal surface has lost its glistening appearance; it is thickened and often distended; the mesentery is swollen from circulatory stasis; and perforation, if it has not already occurred, is impending. The perforations may be either single and large, or multiple and small. I have removed appendices at operations that in this respect resembled a sieve. The general peritoneum is injected, and there is a reddish-brown, foul-smelling, ichorous exudate in the abdominal cavity. Paralysis of the intestinal walls occurs at the onset of the disease. Abdominal distention comes on early and is very great. A most important feature of this form of the disease is that at no time is there any disposition to its localization; there is no exudation of plastic lymph, or at least not sufficient to prevent general infection.

The experimental introduction of large quantities of pathological organisms gives, pathologically, precisely similar conditions, and there is no great difference in the manner of infection.

In other cases the process is much slower, and the degree of bacteriological invasion is materially less. Time has been allowed for walls of lymph to be thrown out, affording a barrier and preventing general peritoneal infection, even though the inflammation reaches a point where perforation occurs.

The small intestines, the mesentery, and the omentum are all attached

together by the exudate, thus forming a posterior wall to the abscess cavity, and giving rise to the percussion dullness and the tumor.

Appendiceal abscesses will sometimes open into the rectum or the vagina, or may burrow backward into the lumbar region, particularly if the appendix is attached in that direction; and in neglected cases of suppurative appendicitis the abscess has been known to find its way behind the liver into the pleural sac, or into distant parts of the abdominal cavity.

While the classification is rather arbitrary, yet most cases can be studied under three divisions, viz., catarrhal, simple catarrhal, obliterating, or relapsing appendicitis; suppurative appendicitis; and perforative, acute, or gangrenous appendicitis.

Catarrhal appendicitis is the form most frequently met with; the inflammation begins in the mucous membrane, is associated with catarrhal exudate or ulceration, and under favorable conditions is followed by subsequent cicatrization, with constriction and obliteration, or on the other hand distention, according to the seat and character of the pathological changes. It is in the catarrhal form of appendicitis, especially when the inflammation is subacute, that there is very little disposition to spontaneous recovery; and these cases should always be looked upon as menacing the life of the patient, a possible exception being in those instances in which the appendix becomes obliterated and is shut off by smooth adhesions from the peritoneal cavity. In these cases of catarrhal appendicitis, with localized peritonitis, the induration resulting from the exudate may remain for months after the primary condition has become quiescent. Cases of catarrhal appendicitis present largely a condition of continued constipation before the onset of the disease; and the overdistended cæcum, with consequent irritation and catarrhal inflammation, provides unusual facilities for the spread of inflammation by continuity.

The exciting cause of that spread of inflammation is undoubtedly the Bacillus coli communis, which quickly infects the peritoneum. This organism, under favorable conditions, is capable of penetrating the walls of the appendix, causing the most virulent inflammatory reaction. In gangrene of the appendix, removed early, pure cultures of this organism have been found, while examinations made in other cases, both of the fulminating and of the suppurative type, have uniformly shown the presence of the colon bacillus. It is not always found alone. Other organisms, such as the Staphylococcus pyogenes aureus and the Streptococcus pyogenes, have also been found in cases of mixed infection, but it is a question of considerable doubt whether the ordinary organisms of suppuration are capable of causing appendicitis.

Where the Bacillus coli communis becomes virulent, its energies are not alone directed against the peritoneum, but also against the intestinal contents. Decomposition fermentation occurs, with the development of poisonous ptomaines and other deleterious animal products, which when absorbed produce profound systemic intoxication. Hence a careful examination of the exudate in appendicitis is likely, under many circumstances, to furnish a clew to more accurate prognosis.

Catarrhal appendicitis is ushered in sometimes by a slight chill, with

nausea, and with slight intestinal obstruction which generally yields to a mild laxative, the acute symptoms subsiding in one, two, or three days, and the patient returning to apparent health; but another attack, more or less severe, follows in a period varying from a month to six months, as the case may be, and the condition then becomes one of *relapsing* or *recurring appendicitis.*

Catarrhal appendicitis may be more severe in some one of its attacks, perforation occurring, or the case going on to the development of an abscess which becomes extraperitoneal from Nature being able to shut off the abdominal cavity by adhesive peritonitis; a tumor then presents itself, suppuration takes place, and the condition becomes one of true *suppurative appendicitis.* These cases do well after operation if too great search is not made for the sloughing appendix, the abscess cavity being washed out and properly drained.

But by far the most serious and fatal cases are those of *fulminating, acute, gangrenous, or perforating appendicitis.* These are the cases in which the symptoms are very rapid in their development. The pain is localized, and generally in the right inguinal region, the point of greatest tenderness on pressure corresponding to what is known as McBurney's point, about two inches from the anterior superior spinous process of the ilium, in a line from that process to the umbilicus. The location of the appendix is however variable, it being sometimes found under the cæcum, sometimes with a long mesentery in the left inguinal region, sometimes above the umbilicus, reaching as far up as the under surface of the liver, or, when abnormally long, deep in the pelvis; and the point of greatest tenderness is wherever the appendix happens to be, but as its usual position is in the right inguinal region, the detection of tenderness there is a sign of considerable value.

DIAGNOSIS.—The diagnosis of appendicitis is certainly becoming better understood by the profession, yet errors are not infrequently made. It has been mistaken for renal, biliary, or intestinal colic, intestinal obstruction, salpingitis, psoas abscess, general or pelvic peritonitis, typhoid fever, impaction of fæces in the cæcum, cancer, tuberculosis, and dilatation of the ureter. The study of appendicitis for the past ten years has had much to do with eliminating that very uncertain term "idiopathic peritonitis," and it has been well said that ninety per cent. of so-called cases of inflammation of the bowels can be traced directly to the appendix vermiformis.

In the clinical study of this disease the *pulse* has been much neglected. It is not only its rate that is important, but its character; the frightened action of the heart apparently presents doubt and uncertainty in the condition of the pulse, a condition that tells that although the beat is but 90 now, in a few hours it will be 120 or more. A too brief examination of the condition of the circulation will not always reveal its true state. Perforation of the appendix, however, is not always followed by an immediate increase in the pulse-rate, though this comes very soon.

The *temperature* cannot be relied upon to any great extent in the classification of cases of appendicitis. A very dangerous perforation may be present, and yet the temperature may remain nearly normal for several hours.

TREATMENT.—Unquestionably very many cases of *catarrhal appendicitis* recover under medical treatment, and without operative interference. The administration of laxatives and of rectal enemata, so as to obtain a free movement of the bowels, is often the only treatment required; but when the patient has suffered a number of attacks, and the disease is of the *relapsing* variety, the operation for removal of the appendix, intermediate or between the attacks, is a very successful procedure.

It is a source of misfortune that there is still a belief among many physicians that the presence of a tumor is necessary for the diagnosis of appendicitis, or as an indication for immediate operation. The very contrary is true. A tumor is practically no part of fulminating appendicitis. With another class of physicians the presence of a tumor is looked upon as a favorable sign, an indication that the case will recover without an operation. While this belief is not so dangerous as the preceding one, it yet leads to disastrous results by allowing the formation of widely dissecting abscesses, and a resulting condition of sapræmia, not very rare in cases of delayed operation. It is certain, however, that in these cases of the *suppurative* form of appendicitis, immediate surgical interference does not become as imperative as in the fulminating variety, and it may be said that when once the tumor has been recognized, the patient's pulse remaining below 90 and the temperature about normal, it is safe to wait, relieving the bowels by rectal enemata, until the end of the tenth or twelfth day, when the abscess which has formed may readily be opened and drained. On the other hand, an error is often made in delaying too long an operation where there is a localized abscess. Too great manipulation of the parts is at times indulged in by the attending or consulting physician, and the abscess may thus be ruptured, leading to a rapidly fatal peritonitis.

When an operation is done for suppurative appendicitis, in a case in which there is present a well-defined abscess cavity, the object of the operator should be to drain that cavity without infecting the general peritoneum. It is far better to do this and resort to a second operation at a later period, should there be a return of symptoms, than to attempt too much in searching for the appendix, risking the opening of the peritoneal cavity. In all operations of this kind careful attention should be paid to the subject of complete, thorough drainage, by the use either of gauze or of a glass drainage tube, the technique being carried out with great completeness. In conditions of *septic peritonitis* due to perforation, associated with any variety of appendicitis, there are times when the free flushing of the peritoneal cavity with saline solutions becomes absolutely necessary.

As to this form of appendicitis, very prompt operative interference is required on the part of the medical attendant, or the patient will pass beyond the skill of the surgeon within a few hours. Cases that result from perforation and the escape of the contents of the appendix, with or without the secretion from the cæcum, but having the Bacillus coli communis as the infective micro-organism, develop septic peritonitis rapidly, and prove fatal in a very large majority of instances. In cases that have been reached early, however, though there has been present a gangrenous condition of the appendix, yet its complete re-

moval has resulted in a fair percentage of recoveries, when the patients would certainly have died had only medical treatment been continued.

As to the mode of removing the appendix, there is perhaps no better method than that of placing a temporary ligature around it near its attachment to the cæcum, after having tied off its mesentery and thus controlled the vessels; then making a flap of the peritoneal coat, invaginating it with three or four fine sutures, loosening the temporary ligature, and inserting the stump within the cæcum, the peritoneal surfaces of which are finally themselves brought together. In this manner the peritoneum, if slightly roughened, very quickly takes on adhesive inflammation, and the entire appendix is obliterated.

CHOLECYSTOTOMY.

In relation to this subject much has been added during the past ten years. Surgeons have been able to reach the bile ducts and gall bladder with a greater degree of freedom than heretofore, owing to the little danger of peritonitis when the operation is thoroughly aseptic; the results, however, in reference to biliary fistula, have not been altogether satisfactory. In some cases the discharge has been a great annoyance to the patient, and has continued, notwithstanding efforts made toward its closure, or to relieve stenosis of the common duct. Attempts have been made by various surgeons to establish a direct communication between the common duct or gall bladder and the small intestine, and *cholecystenterostomy* is apparently becoming an established operation in suitable cases. The reports made thus far of the use of the Murphy button in these cases have certainly been very encouraging, and it is an appliance which should be employed under certain restrictions. When the gall bladder is distended, there is very little difficulty in making an anastomosis between it and either the large or the small intestine, and when there is a moderate dilatation of the cystic duct this may be used satisfactorily for the same purpose. This method should certainly be adopted when there is complete stenosis of the common duct. Incision of the gall bladder or ducts, with removal of the obstruction and immediate closure, is now again receiving much successful attention.

PYLORECTOMY AND GASTRO-ENTEROSTOMY.

Regarding the operations of pylorectomy and gastro-enterostomy, there can be no doubt that the former has made little permanent impression upon the practical surgeon. There are a certain number of cases—not many—in which the operation can be done successfully, and probably the use of the Murphy button would be of benefit in them. In cases where the tumor or other pathological condition can be removed, requiring extensive section of the stomach, it is best to close the opening in this viscus and establish a direct anastomosis independently between some other portion of the organ and the upper end of the duodenum.

Gastro-enterostomy is a justifiable operation in some cases, even though the tumor cannot be removed, and may be employed for the purpose of prolonging life and making the patient more comfortable.

Retroperitoneal Tumors.

There is no department of abdominal surgery which requires more careful investigation, and which is capable of greater improvement in operative management, than that of new growths occurring in the retroperitoneal space.

Anatomical Relations and Pathology.—A careful study of reported cases shows that the most frequent origin of these growths is in the connective tissue of the capsule of the kidneys. None of them can be said to be absolutely benign, not even those made up of normal tissues, such as the lipomata, fibromata, or myxomata, although they may not lead to the formation of metastases or to infiltration of the surrounding parts. From the great size to which they develop, the consequent discomfort which they cause, and their tendency to undergo degenerative changes, they cannot be classed as innocent growths.

Those which spring from the pelvic walls encroach upon and involve the bladder, uterus, and rectum, and often present features difficult of diagnosis. Smaller growths originate from the retroperitoneal lymphatics, the bodies of the vertebræ, and the root of the mesentery. From the change which occurs in their anatomical relations it is often quite impossible to determine the exact point of origin of many large retroperitoneal growths. They almost uniformly present themselves in the line of least resistance (that is, anteriorly), and upon reaching a sufficient size to attract attention they appear at either side of the umbilicus, although they may appear centrally. Owing to circulatory changes within the mass, their liability to subsequent malignant infiltration, and the development of cachectic conditions, they present, clinically, features of great gravity, and are sometimes immediately hazardous to life. The so-called cyst of the broad ligament is very often partially retroperitoneal in character.

There is in these cases no inconsiderable amount of evidence to support the theory of Cohnheim relative to the origin of tumors. They are sometimes active in their growth, often becoming cystic and reaching immense proportions. They often show a marked tendency to recur locally when removed.

The microscope, besides revealing the usual elements of lipoma or myxoma, often presents a dense, round-celled infiltration in the stroma of the growth, indicating a sarcomatous element. Tumors found in the kidneys of young children are, for the most part, mixed tumors, chiefly myo-sarcomata.

In *sarcomatous* growths circulatory changes are likely to occur—thrombosis, with subsequent softening and cystic degeneration.

Lipomata are usually slow-growing, particularly the subserous, and seldom change to other varieties, though they may primarily be mixed in character (myo-lipoma).

Fibromata and *cystomata*, for the most part, spring either from the

walls of the pelvis or from the subperitoneal connective tissue of that region.

DIAGNOSIS OF RETROPERITONEAL TUMORS.—There is no single symptom that is pathognomonic of these growths, and the diagnosis must be made mainly by exclusion. The patient's sex, or the history of the case, may at once exclude the organs of generation, bimanual examination rarely failing to locate the uterine appendages and to determine pathological changes occurring in them. Subperitoneal uterine fibroids are the only *uterine* growths likely to be confused with those under consideration, but solid tumors of the *ovary* and *broad ligament* present greater difficulties, which at times cannot be surmounted. The history of the case, however, together with a painstaking weighing of general symptoms, will assist in clearing up the diagnosis in the event of doubt. Disturbances as regards biliary excretion may occur from pressure of the growth on the common duct. Tumors of the *liver* always move synchronously with respiration; retroperitoneal growths, as a rule, do not. Differentiation from hypertrophy and tumors of the *spleen* presents less difficulty than in the case of the liver. Tumors of the *omentum* lack the fixed position of retroperitoneal growths.

An examination of the urine may give a clew to the diagnosis, and in many cases the withdrawal of fluid by the aspirator, and its careful examination, will throw light on the nature of the tumor. Dullness on percussion is often relative rather than absolute.

Rectal insufflation of hydrogen gas, with distention of the stomach, may be a valuable adjunct to diagnosis, more especially where a careful examination has previously been made and percussion areas have been outlined upon the abdomen; the process of inflation should be carefully watched so that the relation of the intestinal tube to the tumor may be determined.

PROGNOSIS.—Without operative interference there is but one termination to these cases, though the rapidity of the fatal result varies somewhat with the character of the growth. From the clinical histories found in surgical literature, the mean duration of life, after discovery of the tumor, appears to be not more than nine months. Much promise is offered by operative treatment, recovery having followed the removal of retroperitoneal tumors weighing as much as fifty pounds. Incomplete operations have been immediately fatal oftener than when the tumor has been completely removed.

TREATMENT.—Considerable modification in operative detail will from necessity be made in the removal of retroperitoneal growths. Langenbeck's incision for removal of the kidney may be made use of. By separating the peritoneum from the internal border of the tumor and attaching it by sutures to the internal border of the abdominal wound, the whole field of operation becomes extraperitoneal. Removal of the growth by enucleation must be accomplished with great care, and it is always desirable to determine the source of blood supply and the relations of the tumor to the great vessels. Occasionally it is necessary to remove the kidney with the tumor, and the danger of hemorrhage is then very great. As in all abdominal work, the operator must be pre-

pared for any and every possible complication. The cavity must be thoroughly drained after simple enucleation of the tumor, as well as when the kidney is removed with the growth, either by full-sized drainage tubes or by tampons of iodoform gauze. The after-treatment is the same as after other cases of abdominal section.

Intestinal Sutures and Anastomosis.

A trustworthy digest of the multitude of methods proposed for the union of intestines by resection and anastomosis would exceed by far the necessary limitations of this article, and I shall therefore claim a certain latitude in the selection and presentation of those which have appealed more directly to my surgical judgment and personal experience.

In the first place, it may be said that of all the numerous and often fantastic methods of intestinal suture devised before 1880, none deserve especial mention other except those of Lembert, Czerny, and Halstead. A fuller acquaintance with the practical application of these methods will prove a revelation to many who have been disposed to question their utility.

Success in intestinal surgery depends very largely upon manual dexterity, far more than upon the special method employed. There are no short or easy roads by means of which one can arrive at proficiency. A certain amount of experimental surgery must be done by all who enter this field of surgery. He who undertakes the union of resected intestines by simple suture for the first time after having completed an otherwise severe operation, deserves no greater success than he is likely to achieve—namely, the death of his patient.

Two methods of union of intestines are employed, that by simple suture, and that by the use of foreign bodies, such as vegetable or animal plates, rings, or metal buttons. All things being equal, the first method seems at once the more attractive, but certain disadvantages are found to exist which, to the minds of many, are contra-indications to its employment. The time required to effect union by suture alone has been urged as an objection with much persistency. Some writers assert that an hour at least is required to perform a circular enterorrhaphy, time that can rarely be afforded with safety to the patient; but I am convinced through practical demonstration that such an operation can be performed in half the time indicated. Given a patient in moderately good condition and in the hands of a skilful anæsthetist, circular enterorrhaphy can be performed by a surgeon of reasonable skill without greatly increasing the shock. The danger of gangrene and ulceration, with subsequent perforation at the point of suture, is another objection which has been raised, but it may be answered that this misfortune occurs also when other methods are employed. A defective technique is responsible for the accident in the majority of cases. Operating in tissues which through inflammatory processes have a lessened vitality, or drawing sutures too tightly, will account very often for the disastrous consequences.

From an experience with all methods, I find it very difficult to rid myself of the belief that resection and anastomosis by simple suture is

the ideal method, and for this the sutures devised by Lembert and Czerny will be found fully adequate. The condition of the patient being such as to warrant resection, the following precautions are to be observed: The point of section in the intestine must be selected where there can be no doubt of the vitality of the part. Having determined the length of bowel to be removed, it is cleared of intestinal contents by gentle pressure, and is held at each side by the fingers of a trustworthy assistant. The intestine is divided in a slightly oblique manner, removing more at the periphery than at the mesenteric border, so that there may be no doubt as to the sufficiency of the blood supply. It is not desirable to remove a large V-shaped portion of mesentery, but as little should be taken away as is compatible with avoiding acute flexion at the point of resection; the mesenteric vessels should be controlled by immediate ligation with fine catgut.

Czerny sutures of fine silk are next to be placed at intervals of one-fourth of an inch, and tied within the intestine—the tying being delayed until all the sutures are in place. The portion of intestine between the folds of the mesentery requires the most careful attention, and one or two sutures must be placed at this point. When the first row of sutures are tied, all of the mucous membrane will be invaginated. The Lembert sutures should then begin at the mesentery, one or two being placed at the point at which the intestine is not covered by peritoneum, and should be continued, six to the inch, around the entire circumference of the bowel to the point of beginning.

A resection undertaken under suitable conditions, and carried out in the manner described, offers every opportunity for a favorable result.

Conditions sometimes arise when a resection is contra-indicated, either from the extent of intestine which would have to be removed, or from the situation of the parts involved, as in the operation of gastro-enterostomy. In such cases lateral anastomosis by Abbe's method presents distinctive advantages. The method of Abbe is as follows: After resection of the intestine and closure of the divided ends by the Lembert suture, the parts to be joined are brought side to side, and two rows of Lembert sutures are applied, one-fourth of an inch apart, and an inch longer than the proposed incision. The material employed is fine silk, twenty-four inches long, and the needles are left threaded at the end of the row. An opening in the adjoining segments of intestine is now made, four inches long, by scissors. The incision is made one-fourth of an inch from the line of sutures, both rows being on the same side. Any bleeding vessels are caught by hæmostatic forceps. The adjacent cut surfaces are now sutured by a through-and-through, overhand suture, the hemorrhage being controlled in this way. The two free borders are next sutured in a similar manner, after which the openings are approximated, and the first described rows of continuous Lembert sutures are continued around the opening to the point of beginning.

From the description, this process would seem to require too much time. Practically, however, with a little experience, it may be very quickly accomplished. This method presents the advantage of giving a very free communication between the divided intestines, the lack of which is a serious objection to the use of plates and buttons.

A great many ingenious methods have been devised to lessen the

time required in doing intestinal anastomosis, and at the same time to avoid many of the unfortunate results which follow simple suture. All of these have been employed successfully by different operators, and merit impartial investigation.

Senn has been a pioneer in this field of surgery, and undoubtedly the decalcified bone plates invented by him are much more satisfactory than any of the similar devices employed. Plates made from vegetable substances, such as potato and turnip, or from rawhide or catgut, are inferior when applied for the purposes for which they were designed. It may be urged, upon substantial evidence, that the communication established when any of these methods is used is insufficient, leading to either immediate or remote obstruction; and as an evidence of the general dissatisfaction felt by surgeons in employing any of these methods, it is only necessary to call attention to the fact that each has been abandoned as soon as a more recent plan has been suggested.

Recently there has been presented a device for both intestinal resection and anastomosis that for ingenious construction, simplicity, and rapidity of application, excels all others, namely, the Murphy button. Already a large number of cases in which this instrument has been successfully employed have been reported; but while I am not disposed to undervalue the service rendered to surgery by this invention, it can hardly be said that sufficient experience has as yet been accumulated to warrant its general employment. To those who have not done much experimental work in intestinal surgery, however, it presents a method full of promise. Many circumstances, such as the surroundings of the patient, the lack of skilled assistance, or the patient's enfeebled condition, may make it advisable to use the Murphy button in preference to adopting any other method. Certainly no abdominal surgeon should fail to be prepared to use this valuable, time-saving, and often life-saving device.

HERNIA.

BY

JOHN A. WYETH, M.D.,

OF NEW YORK.

A HERNIA, literally defined, is a tumor formed by the escape of the whole or a portion of any viscus from its normal cavity. By common consent, the term is now almost wholly restricted to protrusions of *intestine* or *omentum* (or both), from the cavity of the *abdomen* or *pelvis*, and these protrusions may occur through an opening which is *congenital* or *acquired*. *Complete inguinal hernia* following the descent of a testicle, or *ventral hernia* due to failure of perfect union in the aponeuroses of the abdominal muscles, are instances of the former; while a protrusion of the intestine after a *wound* of the abdominal wall is an example of hernia through an acquired opening. The hernia may take place into an adjoining cavity, as the thorax (diaphragmatic), or may protrude beneath the skin (femoral, umbilical, ventral, etc.).

CLASSIFICATION OF HERNIÆ.

Herniæ are classified according to their place of escape: *inguinal*, *femoral*, *umbilical*, *diaphragmatic*, *gluteal*, *obturator*, *lumbar*, *vaginal*, *pudendal*, and *perineal*. The term *ventral* is applied to all herniæ occurring at points on the abdominal wall other than those indicated in the classification just given. Of herniæ in general, the inguinal variety forms about 80 per cent. of all cases; femoral, 10; umbilical, 5; the remaining varieties, 5. Of every five patients affected with hernia four are males. Inguinal hernia in males occurs more often in the first ten years of life than in any subsequent decade, the period from the twentieth to the fortieth year being next in order of frequency. According to Kingdon, femoral hernia in *males* of all ages is met with in four of every hundred cases; in the first decade in one of every three hundred; in the second two per cent.; in the third and fourth together, four and a half per cent.; in the fifth and sixth, six per cent.; and after this, eight per cent. In *females* inguinal and femoral herniæ are met with in about equal proportions. The latter variety is rarely met with before puberty, but occurs chiefly during the child-bearing period (Thomas Bryant).

Structure of Herniæ.

The contents of the hernia are enclosed in a *sac*, almost always formed by the peritoneum lining the abdominal cavity. The sac may be carried immediately in front of the escaping intestine or omentum (femoral, umbilical, etc.), or these viscera may descend into a sac already formed by the escape of some other organ (inguinal, scrotal). In the rare cases of hernia of those portions of the large intestine not covered by peritoneum, there is no true sac. The sac of a hernia is generally described as possessing a *mouth*, that part which looks directly into the abdominal cavity; a *neck*, the constricted portion at the opening into the abdominal cavity; a *body*, and a *fundus*, or most protruding portion. When the intestine alone enters into the formation of a hernia, it is called *enterocele;* if omentum alone, *epiplocele;* if both are enclosed in the sac, *entero-epiplocele.* The coverings of a hernia outside of the sac will vary with its location, and will be given in the consideration of the different varieties.

As far as the sac itself is concerned, it varies in thickness, generally in proportion to the age of the hernia. In a recent hernia, it is exceedingly thin, while in some forms of scrotal hernia, of long duration, it may be as much as $\frac{1}{16}$ or $\frac{1}{8}$ of an inch in thickness. A hernia is said to be *reducible* when the contents of the sac can by any means be returned into the cavity of the abdomen; *irreducible* when adhesions exist to such an extent that this cannot be effected; *strangulated* when the circulation in the tumor is arrested by constriction at any portion (usually at the neck).

Special Herniæ.

Inguinal Hernia.—An inguinal hernia may be *direct* or *indirect*, *complete* or *incomplete*, *congenital* or *acquired.* The *indirect* or "*oblique*" variety is much the most frequently met with. In the *male*, the contents pass into the *internal abdominal ring* and follow the *spermatic cord* along the inguinal canal, at times descending into the *tunica vaginalis testis.* In the *female*, the descent is into the canal of Nuck, following the round ligament in the inguinal canal, and at times as far as the labium. *The epigastric vessels are internal to the neck and behind the body of an oblique inguinal hernia.* (1, Fig. 1721.)

A *direct* hernia does not enter the *internal* abdominal ring, but pushes the fascia which is to the inner side of the epigastric vessels and immediately behind the external ring directly in front of the tumor and *out at the external ring.*

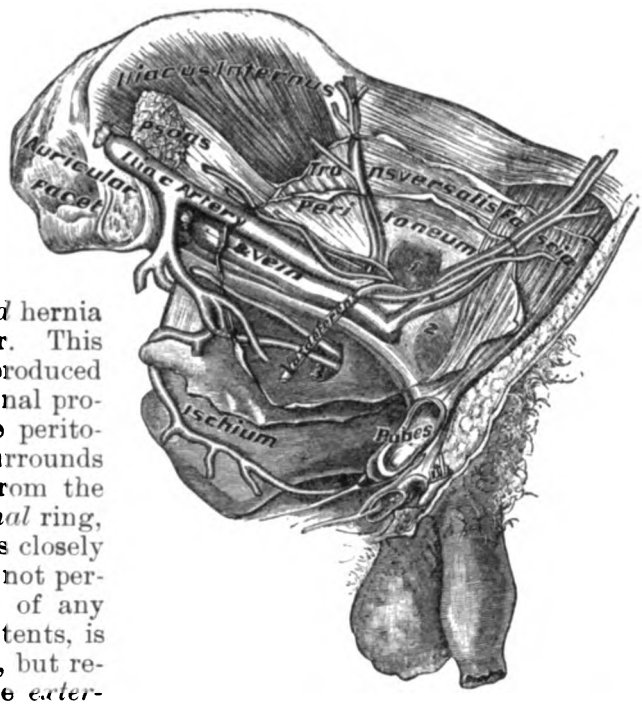
The epigastric vessels are external to the neck, and may be displaced slightly in front and to the outer side of a direct inguinal hernia. (2, Fig. 1721.)

An inguinal hernia is said to be *complete* when the contents protrude beyond the *external* ring; *incomplete* when the tumor is within this limit. A *complete* inguinal hernia in the *male* may descend into the cavity of the tunica vaginalis testis, the contents resting in contact with the testicle (*congenital*, Fig. 1722), or it may be arrested in the tubu-

lar sheath which surrounds the spermatic cord (*infantile*), the contents not in contact with, but pressing upon, the testicle. (Fig. 1723.)

There is a third and rarer form of inguinal hernia known as the *encysted* hernia of Sir Astley Cooper. This variety of hernia is produced as follows: The vaginal process, that part of the peritoneal pouch which surrounds the spermatic cord from the *internal* to the *external* ring, and which normally is closely adherent to the cord, not permitting the entrance of any of the abdominal contents, is closed at the *internal*, but remains unclosed at the *external* ring. The hernia, descending, pushes before it the parietal peritoneum as in ordinary hernia, and carries it gradually downward until it is protruded into the unclosed vaginal process below, forming in this way two sacs.

Fig. 1721.



Inguinal Hernia. 1. The internal abdominal ring; 2. The part through which a direct inguinal hernia pushes its way.

It will be seen that an oblique inguinal hernia is *congenital* when it follows exactly in the route travelled by the *testicle* in its descent, and lies in contact with this organ. This form of hernia exists generally at birth, but it has been known to occur after birth and even in adult life, in rare instances when the vaginal process and tunica funiculi have not firmly united and are easily broken through.

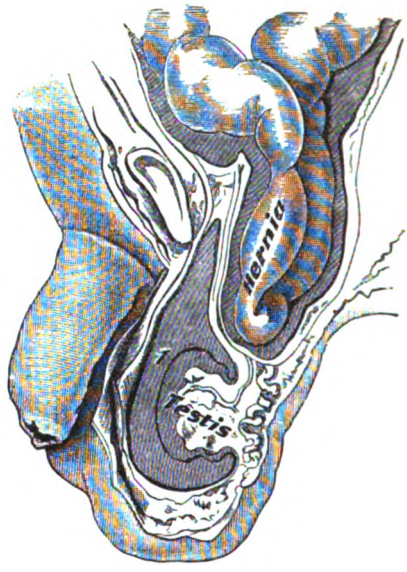
Fig. 1722.

Congenital Inguinal Hernia.

In an *infantile* hernia, which occurs, as its name implies, usually soon after birth, but which may also, in exceptional instances, occur later in life, the intestine descends along the tubular sheath which surrounds the spermatic cord, but finds this sheath closely attached to the cord at the upper margin of the testicle where it is arrested; and while by its weight it may descend

into the scrotum and pass beyond the level of the testicle, it never lies in contact with it, as in the case of congenital oblique inguinal hernia. In general, therefore, we may say, that an inguinal hernia is *congenital* or *acquired*, the *congenital* form existing at birth while the *acquired* hernia is one which comes on after birth, and is caused chiefly by the pressure of the intestine or omentum from *gravity* and *muscular effort* combined.

Fig. 1723.

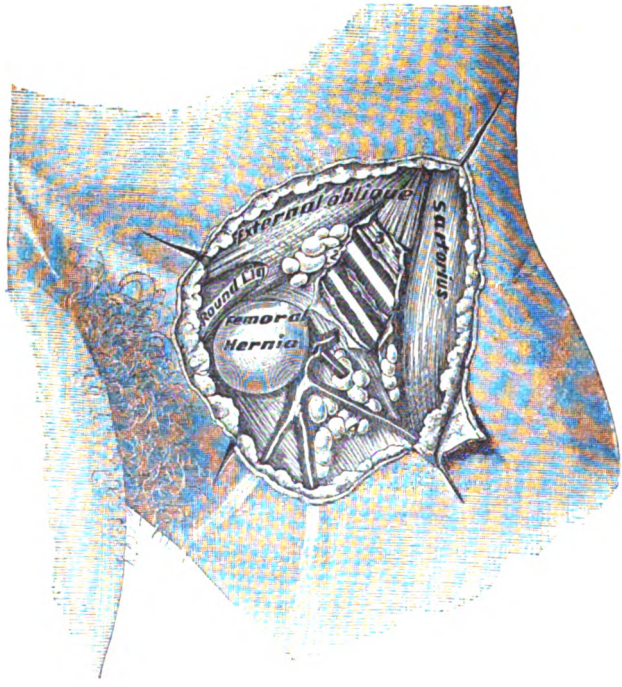


Infantile Inguinal Hernia.

FEMORAL HERNIA.—This is always an *acquired* hernia. The tumor enters the *femoral* or *crural* canal beneath Poupart's ligament, just to the inner side of the iliac and femoral vein. (Fig. 1724.) If it remains in the crural sheath, it is an *incomplete*, but if it protrudes at the *saphenous opening*, it is a *complete* femoral hernia.

UMBILICAL HERNIA.—Umbilical hernia is either congenital or acquired. It exists not infrequently at birth, in both sexes, on account of the patulous condition of the omphalo-mesenteric duct. In this variety the only covering of the tumor is the *sheath* of the umbilical cord. In the acquired form, the intestine escapes either directly through the navel or more frequently to one side of this contraction. The sac of an *acquired umbilical* hernia is composed of the *parietal layer of the peritoneum*, and the outer covering of *integument* and *subcutaneous fat*.

Fig. 1724.



Femoral Hernia, Showing Relation to Femoral Vein.

VENTRAL HERNIA.—This may also be congenital or acquired. The protrusion may occur at birth, as a result of failure of development in the muscles of the abdomen. It is usually met with

along the linea alba above the umbilicus. The acquired form may occur at any point, and results from an accidental or surgical wound of the muscles and fasciæ, and occasionally from pregnancy. It is quite frequently met with in the wound of incision for laparotomy.

RARER FORMS OF HERNIA.—*Diaphragmatic hernia* is usually due to a wound or rupture of the diaphragm. It may result from a congenital defect in this muscle. It generally occurs on the left side, on account of the protection afforded by the liver on the right side.

Gluteal hernia is extremely rare. The escape of the viscus is through the *sciatic* notch, and it may occur above or below the pyriformis muscle.

Obturator hernia takes place through the *thyroid* (obturator) foramen, usually into the upper portion of the canal which gives exit to the obturator vessels and nerves. It is more common in women than in men.

Lumbar hernia occurs in the region situated between the twelfth rib and the crest of the ilium.

Hernia into the *vagina* occurs as a rule with partial or complete *prolapse* of the *uterus*, or after loss of substance allowing escape of the intestine.

Perineal hernia descends to one side of the median raphé of the perineum, between the *bladder* and the rectum in the male—between the *rectum* and the *vagina* in the female—travelling along the inner slope of the levator ani muscle. It is extremely rare, but has been known to follow the operation of lithotomy.

Pudendal hernia, in which the bowel passes down between the *ramus of the ischium* and the *vagina*, forming a tumor in the labium, and *sacro-rectal* hernia, which is described as having occurred from failure of the junction by ossification of the separate bones composing the sacrum, are rarely met with.

There is also at times a hernia of the *ovary* into the canal of Nuck, and there are two instances on record in which a hernia of the Fallopian tube alone existed in this canal. One of these cases occurred in my own practice, and the hernia, having become strangulated, caused the death of the woman by infectious peritonitis, the infection spreading through the disintegrating sac into the peritoneal cavity. The *bladder* has also been known to protrude into the inguinal canal and through the external ring, and I have witnessed two cases in which the bladder was wounded in an operation for supposed intestinal hernia of the oblique inguinal variety.

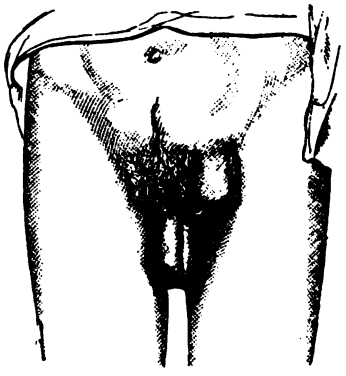
SYMPTOMS, DIAGNOSIS, AND TREATMENT OF HERNIA.

SYMPTOMS AND DIAGNOSIS OF INGUINAL HERNIA.—When gradually acquired, the presence of a small swelling or tumor near the centre of Poupart's ligament, or a little to the inner side of this point, is usually the first symptom of *inguinal hernia*. In a certain proportion of cases, the appearance of the swelling has been preceded by a feeling of weakness or uneasiness referred to this region, which only disappeared when the recumbent posture was assumed, or when strong upward pressure was made by the hand.

If suddenly acquired, the presence of the tumor is noticed soon after a violent strain of the abdominal muscles. Pain is almost always present, and the patient is generally aware that rupture has occurred.

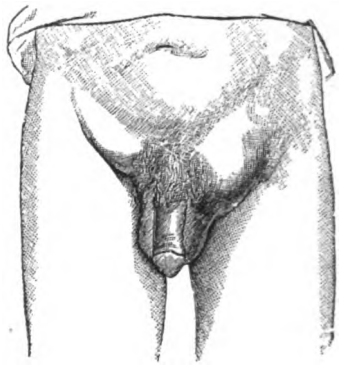
The diagnosis of inguinal hernia involves the differentiation (1) between the *direct* and *indirect* varieties, and (2) between inguinal and femoral herniæ and the various swellings which may occur in this

Fig. 1725.



Direct Inguinal Hernia. (T. Bryant.)

Fig. 1726.



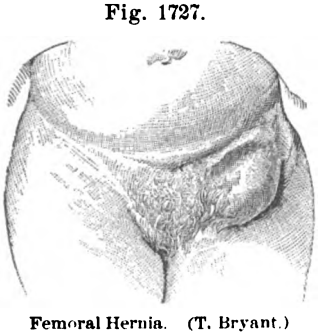
Indirect or Oblique Inguinal Hernia. (T. Bryant.)

region—varicocele, hydrocele, bubo, incarcerated testicle, ovary, cyst, Fallopian tube, new formations, abscess, and aneurism.

A *direct* inguinal hernia is exceptional. The tumor formed by it is apt to be spherical (1725), is situated nearer the median line than the indirect hernia, and its neck will be found to enter the abdominal cavity immediately behind the external ring.

The tumor formed by an *oblique inguinal* hernia (Fig. 1726) is oval or elliptical in the incomplete, and oval or pyriform in the complete variety. The history of the swelling, if gradually developed, will indicate that the tumor commenced at the middle of Poupart's ligament and travelled toward the pubes. In cases of long standing, and when the tumor is of large size, the diagnosis between the direct and indirect form is scarcely possible, from the fact that the inner edge of the internal ring has been dragged down until it occupies a position just behind the external opening.

Fig. 1727.



Femoral Hernia. (T. Bryant.)

A *femoral* hernia is situated below Poupart's ligament, and near its attachment to the spine of the pubis, to the inner side of the femoral vessels (Fig. 1727). In lean subjects the neck of the tumor can readily be traced to the canal at this point. In corpulent persons the diagnosis is more difficult.

The swelling of *varicocele* commences in the lower posterior portion of the cord and increases gradually upward. To the touch the distended veins feel like worms. The tumor has none of the elasticity of hernia. In the recumbent posture a varicocele and a non-incarcerated inguinal hernia will both disappear. If after the disappearance firm pressure be made

with the fingers, and the patient be directed to resume the upright posture, the varicocele, despite the pressure, will return, while the hernia cannot descend. Coughing does not give an impulse to varicocele.

The accumulation of fluid in *hydrocele of the tunica vaginalis* is first noticed in the lowest portion of the scrotum; the swelling is spherical at first, and becomes pyriform after the cord is involved. Hydrocele is translucent, and fluctuation may be detected. *Hydrocele of the cord*, near the external ring or within the inguinal canal, may make differentiation more difficult. The impulse from coughing is not marked in hydrocele of the cord, the sense of weakness is absent, and the cyst is small and usually remains so. If, after full consideration, doubt still exists, aseptic aspiration with the finest hypodermic needle will clear up the diagnosis without danger.

Bubo.—In *chronic adenitis* the glandular character of the swelling may be made out distinctly. In *acute adenitis*, although the perilymphatic infiltration is so extensive that the glands cannot be recognized, the redness of the skin, the great tenderness on pressure, and the superficial character of the pain, with the coexistence of a urethritis or sore upon the penis or scrotum, will commonly serve to establish the character of the lesion.

Incarcerated testicle may be suspected if there is absence of the organ on that side. If the testicle is not extensively atrophied, pressure will give the peculiar and characteristic sense of pain experienced in injuries of this organ.

In *neoplasms* there is a history of progressive development entirely disassociated from that of hernia, as heretofore detailed.

Incarceration, temporary or permanent, of an *ovary* in the canal of Nuck may be suspected when on coughing there is no marked impulse transmitted to the tumor, and when pain is increased at the menstrual period.

Cysts of the canal of Nuck or of the inguinal canal are rare, but have been met with in a number of cases—four or five within my own experience. They differ from herniæ in general since they are irreducible, and do not impart a well-marked impulse on coughing.

Abscess, which not infrequently appears above Poupart's ligament, is accompanied with inflammatory and septic symptoms which do not accompany hernia. Abscess in this region occurs with adenitis, as just stated, and with osteitis of the vertebræ or ilium. The recognition of either of these lesions will lead to the correct diagnosis.

In the manipulation of a hernial tumor, the sensation imparted to the fingers will vary with the contents of the sac and with the condition of the mass. If it contain only *omentum*, it is doughy to the feel, and will yield dulness on percussion. If the mass is composed of *intestine*, it is elastic and more or less tympanitic on percussion. The "colicky" pain felt when the intestine is firmly compressed is of diagnostic value in determining the contents of a hernia. Whether a hernia is reducible or not, there is always a perceptible impulse imparted to the tumor in coughing or sneezing.

In *strangulated* hernia the diagnosis rests first upon the existence of a tumor, which is present in almost all cases, though in very exceptional instances there is no protrusion noticeable. The next symptom is pain at the seat of the hernia. In character it is compared to that

of *intestinal colic*, and when not intensified in the neighborhood of the strangulation is usually referred to the umbilical region. The symptoms of occlusion are more remote, and while very strong in a diagnostic point of view, are not of much importance practically, because a diagnosis should be made and treatment instituted before the effects of obstruction are made evident. The cessation of fæcal discharges may not occur in intestinal obstruction for several days after the occurrence of occlusion, when the small intestine alone is involved, since the contents of the bowel below the constricted point may be evacuated. The *vomiting* of recently ingested food or drinks, followed by stercoraceous matter, is the last and strongest evidence of occlusion. *Distention* of the abdominal walls, with *tympanitic resonance*, is, when taken in connection with other symptoms, a strong link in the chain which makes the diagnosis conclusive. *Hiccough* is present in many cases, but is apt to be one of the later evidences of obstruction. *Shock*, that condition in which, as a result of emotion or injury, the functions of the nerve-centres are more or less completely suspended, is present in a varying degree in almost all cases of strangulated hernia. It is evident in the rapid and weak pulse, occasionally missing a beat, or varying in exacerbations of rapidity and slowness; in coldness of the skin, with unnatural perspiration; and in lack of facial mobility, the eyes being wide open and staring, and the only expression being that of pain and great anxiety. In omental hernia the pain is not so intense as in intestinal hernia, and the symptoms of occlusion are always absent.

TREATMENT OF INGUINAL HERNIA.—The treatment of *inguinal hernia* may be considered under the following heads: 1, the reducible; 2, the irreducible (not strangulated); 3, strangulated. For a hernia not strangulated, the operative measures are *palliative* and *curative;* in strangulated hernia early operation is always indicated.

A *reducible inguinal hernia* should be returned to the abdominal cavity and retained there by the constant and careful employment of a truss, or a bandage and compress. In accomplishing reduction the patient should rest upon the back with the thighs flexed upon the abdomen and the pelvis elevated. In this position gravity carries the intestine and omentum toward the diaphragm, and this traction from within readily reduces the mass. If this should not succeed, gentle pressure with the hand will suffice. Once reduced, an effort should be made to prevent recurrence.

For *incomplete* or slight hernia, in patients who are not compelled to do heavy work, an elastic truss is most comfortable and safe. In all other cases the steel spring truss must be worn. The pad will vary in size as the character of the rupture may require. Hard-rubber or wooden pads are preferable in the great majority of cases. A truss should be applied before leaving the recumbent posture, and should not be removed again until this posture is resumed. When ordering a truss the following rule should be observed: Describe fully the character of the hernia. If the case is one of complete inguinal hernia of the left side, take a lead tape, lay one end directly over the internal ring of this side, and carry the tape across the abdomen to the right, just below the anterior superior spine of the right ilium, and across

the gluteal region to the same point below the left superior spinous process. Press the malleable lead closely to the integument in order to get an exact outline of the surface to which the truss is to be applied, and trace this directly upon a sheet of paper. The instrument-maker by using this tracing can model the spring to fit more comfortably, and afterwards can temper the metal to make the required pressure. · When there exists a bilateral hernia a double truss should be worn. A fair temporary truss may be made as follows: A piece of cloth, or a tuft of wool, cotton, or oakum, is rolled into a compress about half the size of the fist, is then covered with adhesive plaster (the adhesive surface being external), and is laid immediately over the inguinal canal after the hernia has been reduced; while the patient is in the recumbent posture, a spica bandage is carried around the pelvis and thigh so that the compress is held firmly in position. The adhesive plaster which surrounds the compress adheres to the skin and to the spica bandage.

When an inguinal hernia cannot be retained by a truss, operative interference is indicated. In cases where the hernia can be retained, and yet interferes with the comfort or usefulness of the individual, operation for radical cure is also advisable. In irreducible hernia which interferes with comfort or usefulness, or which is increasing in volume, or which exists in persons going beyond the reach of proper surgical aid, operation for radical cure should be undertaken. In aged persons, operation should be avoided unless strangulation occurs. By reason of the great advances due to careful asepsis and improved operative technique, together with the increased safety of anæsthesia as practised at this time, even conservative surgeons are leaning to the side of operative interference. That death is exceedingly rare after this operation when done in properly selected cases and by experienced operators, will be seen from a study of the statistics of Prof. Eduard Bassini, of Padua, who had one death in 251 cases, this being from pneumonia after the wound had healed without suppuration. Svennsen and Erdman record 200 operations with no death; Lucas-Championnière 266 cases with one death; Kocher 119 operations with one death (due to pulmonary embolism on the fifteenth day after operation, the wound being completely healed); Macewen 98 cases with one death, from scarlet fever; and Roswell Park 85 cases with no deaths (Dawbarn). In my own experience no death has resulted.

Of the *procedures for the radical cure of inguinal hernia* I would at this date (August, 1895) advise that of Bassini, with an occasional modification in the management of the sac.

The operation is performed as follows:—

Make an incision through the skin and fat down to the aponeurosis of the external oblique muscle, from the spine of the pubis upward and outward about two inches internal to the anterior superior spine of the ilium. Upon a grooved director inserted beneath the aponeurosis of the external oblique muscle, through the external abdominal ring, and superficial to the hernial sac and structures of the cord, divide this aponeurosis about one inch beyond the internal ring. The upper flap of this aponeurosis is dissected toward the median line (preferably with the scissors) until the conjoined tendon of the internal oblique and transversalis muscles is brought well into view. The lower flap is then dissected from its underlying fascia until the shelving edge of Poupart's ligament is exposed.

With the finger or with dull-pointed scissors, the structures of the spermatic cord and the hernial sac are carefully dissected out of the inguinal canal. The hernial sac should be freed from all attachments well down to the inner surface of the internal ring. The operator is now ready to open the sac and reduce the contents of the hernia. This is done preferably by picking up the sac with two pairs of forceps and carefully cutting through it until a few drops of serum exude. This liquid is almost universally present in cases of hernia, and when this is non-strangulated is clear and straw-colored. A grooved director can now be inserted through this small puncture and the sac further divided so that the finger may be admitted and the contents examined by the touch. If the sac contain only intestine, which is non-adherent, it can readily be reduced. If there be only an ordinary mass of omentum, it may also be returned to the abdominal cavity, unless it has been long compressed and changed in structure by its location in the sac. When, however, the omentum is indurated or the mass large, it should be tied off with strong, carefully asepticized catgut (boiled in alcohol for at least four hours before being used). It is important to be assured that there are no adhesions in the deeper portions of the sac, and that the reduction of the contents is complete. The sac, being freed from all attachments to the cord as well as to the immediate edges of the internal ring, is now twisted so as to completely occlude it at the neck, when it is transfixed and tied with a double, strong catgut ligature. It is then cut off about ¼ inch from the ligature and allowed to drop. Bassini recommends, when the hernia is very large and the openings of the internal ring and of the sac are broad, that there be another row of sutures in the divided sac. In case of a congenital hernia, the sac should be cut off one inch above the testis, and should be separated from the cord up to the internal ring, as

Fig. 1728. Fig. 1729. Fig. 1730.

First Stage. Second Stage. Third Stage.

Bassini's Operation for the Radical Cure of Inguinal Hernia.

in the method just described. This divided sac can be twisted and tied off in the same way as in the acquired form of hernia. Fig. 1728 shows the incision through the skin, the first step in Bassini's operation;—at *aa*, the reflected flap of the external oblique muscle. The sac is tied off and dropped back into the abdominal cavity, while the spermatic cord is held to one side by a blunt hook.

The second step consists in stitching the conjoined tendon of the external oblique and transversalis muscles to the shelving edge of Poupart's ligament, preferably by sutures of Kangaroo tendon, or next in order strong silk, carefully sterilized. These sutures can be inserted by the ordinary curved needles. In my own work I prefer the Hagedorn, but any good needle will suffice. Care must be taken not to wound the femoral vein or the external iliac vein which lie close to the shelving edge of Poupart's ligament, which is included in the suture. It is my practice to insert a very dull grooved director over the vein, and to carry the point of the needle along the groove until it is turned upward to transfix the shelving edge of Poupart's ligament. The posterior wall of the canal, composed of the transversalis fascia, should be included in the upper grasp of the needle along the conjoined tendon. From four to six sutures inserted in this way will suffice. The lower

two sutures, near the pubis, should include a portion of the outer border of the rectus muscle. As the sutures are applied from below upward, care must be taken that the last stitch does not too tightly squeeze the cord. The stitches should take a good bite through all the structures on the inner side of the canal to be closed, but should not go more than a quarter of an inch from the shelving edge of Poupart's ligament. In Fig. 1729 this part of the operation is illustrated, with all of the sutures inserted at this stage of the operation excepting one or two at the lower edge. It is seen that the cord makes its exit through the abdominal wall at the upper end of the inguinal canal instead of at the lower end, as formerly. The reflected flaps of the aponeurosis of the external oblique muscle are still seen. The next step in the operation is to permit the cord to drop into the wound, resting upon the first row of sutures, while the final row of sutures closes the aponeurosis of the external oblique muscle over its line as shown in Fig. 1730. An outside row of catgut sutures closes the wound in the skin, and the operation is completed. Under aseptic conditions, it is not advisable to use any drainage.

It has been my practice to close the wound in the skin with a continuous suture, hermetically sealing it with sterilized iodoform collodion and putting the ordinary iodoformized and sterilized gauze dressing over all. It is a matter of great importance, for the first four or five days after the operation, to prevent the infiltration of urine into the dressing, or any exposure of the wounded surfaces to infection. The patient should be kept in bed, preferably for six weeks when this is possible, and should not be allowed to turn over from the recumbent posture for from six to ten days.

The operation which I now practise, and which gives the greatest proportion of cures, is to carry out the procedure of Bassini in regard to the abdominal wound, but to treat the sac after Macewen's method. The sac should be thoroughly dissected loose from the cord and structures of the canal well beyond the inner surface of the internal ring, freeing with it a small circle of peritoneum from the internal surface of the internal oblique and transversalis muscles (transversalis fascia). Opening the sac and reducing the contents, a large catgut suture in a half-curved Hagedorn needle is carried through the sac at its fundus and tied. This suture is then carried through both walls of the sac a half-inch lower down, and the process is repeated until it passes through the neck of the sac on a level with the inner surface of the abdominal wall, the needle pointing toward the nipple of that side. The needle is now carried on the index finger as a guide, upward between the parietal peritoneum and the abdominal muscles, and is made to come out through the muscles and skin about one inch above the upper margin of the internal ring. Having again made sure that the contents of the sac have been reduced, traction on this suture throws the sac into a series of folds, and gradually pulls the wrinkled mass beyond the internal ring, where it is secured by warping the free end over a roll of iodoformized gauze where it emerges from the skin. Pressure with the finger may be necessary to completely invaginate the folded sac. As before stated, the wound is closed as advised in Bassini's operation.

TREATMENT OF STRANGULATED INGUINAL HERNIA.—With the first symptom of strangulation the patient should be placed in the dorsal decubitus, with the foot of the bed elevated at least twelve inches, the pelvis raised upon a pillow, the legs flexed on the thighs and the thighs

on the abdomen, so that the intestines and omentum will gravitate toward the diaphragm; or the knee-shoulder position may be assumed. Towels dipped in hot water and partially squeezed out should be laid upon the tumor. The question of administering morphine should be determined in good part by the character of the patient. It should be borne in mind that unless posture and careful taxis cause a reduction of the hernia, operation is imperative, and if the patient is relieved from pain by morphine he may be lulled into a false sense of security, and may decline an operation the importance of which he is unable to appreciate. In the manipulation (*taxis*), the neck of the tumor should be grasped and steadied between the thumb and fingers of one hand, while the contents are pushed gently in the direction of the canal with the other. Taxis should not be continued longer than five or ten minutes at any one effort. It may be repeated at intervals of ten minutes, or from ten minutes to half an hour, for the first three or four hours of the history of strangulation. The dangers of delay are so great, however, and the safety of operation so assured, that operation should not be postponed longer than three or four hours. The manipulation of a hernial tumor after six hours of strangulation is of doubtful propriety, and after twelve hours should not be attempted at all after the anæsthetic is administered. It is not only to be condemned for the injury one may inflict upon the parts involved, but on account of the procrastination in operative interference which it invites. It is true that occasionally reduction is effected after symptoms of strangulation lasting for a longer period than this; but these cases are so extremely rare, and the danger of a fatal termination so much increased by the delay, that it will be wiser to proceed at once to the operation. In justification of early operation, it may be said that the large majority of cases which end fatally are those in which strangulation has existed for from twelve to twenty-four hours and upward before surgical interference; and that abdominal section in a patient not exhausted by suffering or disease is almost free from danger. The high rate of mortality after kelotomy will only be materially reduced when it is performed not later than twelve hours, and better still, within the first six hours of strangulation.

Operation.—The pubes, scrotum, and integument near the tumor, should be shaved, scrubbed with a clean, stiff brush, with green soap and warm water, washed with ether in order to dissolve the fat and clear out the sebaceous follicles, and finally bathed with a 1–1000 sublimate solution. The patient, fully anæsthetized, should be placed upon a table nearest the edge most convenient to the operator, with the pelvis slightly elevated. Before proceeding with the operation, a final effort at reduction may be made. An assistant is directed to place the legs of the patient over his shoulders, and to lift him until nothing but the patient's shoulders and occiput rest upon the table. While in this position careful taxis should be made. If after five minutes reduction is not effected, the attempt should be abandoned. The parts about the field of operation should be covered with warm sublimate towels (1–3000), leaving a space about six by eight inches uncovered. In males the prepuce should be sealed over with rubber protective melted on with chloroform.

The incision should be in the long axis of the tumor, and may be made by cutting directly down upon the mass, or by pinching up the skin and fat immediately over the swelling, transfixing it, and cutting outward. It should be of good length, extending from one inch above the internal ring to the spine of the pubis. All bleeding should be arrested at once with catgut ligatures. The wound should be irrigated with 1–3000 sublimate solution occasionally, as the operation progresses, until the sac and peritoneal cavity are opened, but after this irrigation is not permissible until the cavity is again closed by folding in or ligature of the sac.

The first difficult point in the operation is the recognition of the sac. This comes into view when the skin, fat, and deep fascia have been divided and are held apart by retractors. When one is uncertain as to when the sac is reached, it is a safe procedure to grasp the coverings of the hernia with two "rat-tooth" forceps, lifting only a very thin portion at each time, and carefully cutting with the scalpel or dull scissors between the grasp of the two pairs of forceps, until finally a few drops of serum, clear or straw-colored in the case of a recently strangulated hernia, black or bloody looking fluid in the case of a long strangulated or necrotic mass, exude from the puncture. This will occur in the proportion of forty-nine out of fifty operations. In very rare cases the sac may be adherent to the intestine, and puncture of the gut has occurred under such circumstances. Even should this occur, it is not dangerous, as the opening can be closed before reduction is effected by Lembert's suture. As the fluid begins to escape through the puncture in the sac, a grooved director with a very dull point is inserted through the aperture, and the sac is divided until the finger can be admitted, when this is introduced and the sac further incised as may be desired. The contents are now clearly in view. A thorough irrigation should be made, using warm boric-acid solution, or water that has been boiled and allowed to cool to 110° or 120° F. The strangulation of the neck prevents the irrigating fluid or any septic matter from entering the peritoneal cavity. The hands of the operator should now be carefully re-cleansed. By carrying the index finger of the left hand toward the constriction, with the palmar surface upward, the nail can be slipped under the constricting band, usually at the neck of the sac. Very frequently I have been able to stretch or tear this band of constriction with the finger nail unaided by the knife, by making pressure directly upward. The intestine is not injured in the least, nor can any harm be done. Within a minute or two the nail and the soft end of the finger will so stretch the band of constriction around the hernial contents that the intestine drops back into the peritoneal cavity. If this cannot be done with the finger nail and finger, these should be introduced in the same way, and a long, probe-pointed bistoury should be carried flat-wise along the palmar aspect of the finger until the dulled point passes between the sharp edge of the ring and the nail. The edge is now turned upward against the ring, and is pressed against this by the finger upon which it rests. The direction of this cut should be upward and very slightly inward in inguinal hernia. It should not extend beyond an eighth of an inch. The finger nail is usually sufficient to enlarge the opening after the first few fibres are divided.

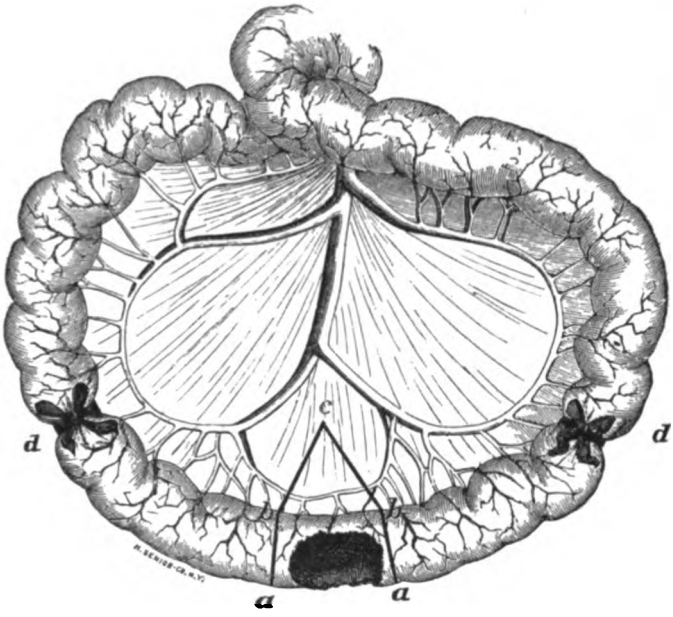
Before allowing the contents of the hernia to return to the peritoneal cavity, these should be carefully examined as to their condition. As soon as the strangulation is relieved, the wound and exposed intestine or omentum should be covered with towels dipped in hot boric-acid or Thiersch's solution, and should be left for from five to ten minutes in order to determine whether the circulation can be re-established or not. The color of strangulated intestine varies from a pinkish-gray to a black, motley color. The contents of a hernial sac should not be returned into the abdomen unless the color changes to a healthy red after the strangulation is freely relieved. If, after from five to twenty minutes, the circulation is established, reduction should be effected. In accomplishing this, posture is important, and the intestine should be carefully pushed in between the thumb and finger. Once returned, the inner opening should be stopped with the finger or a plug of sterilized gauze fastened to a string or holder, so that blood, the contents of the sac, or the irrigating fluid may not run into the peritoneal cavity. Sublimate solution should be discontinued always after the hernia is reduced, and the boric-acid solution or sterilized warm water used instead. If omentum is contained in the hernia, if it is small in surface, say one inch in breadth and about one inch long, and is unchanged materially, it may be reduced with the intestine; but if the strangulation has existed for some time, or if the omental tissue is indurated and abnormal, and in any way suggests the possibility of infection, it should be withdrawn through the opening until healthy omentum is reached, and through this healthy portion catgut ligatures should be passed and tied, and the part beyond the ligature cut away. In large herniæ, where a great deal of omentum has been imprisoned, it is usually the best practice to treat the protruding mass as just described. The stump of the omentum drops back into the peritoneal cavity. If the condition of the patient is such as to warrant a further operation at this time, the operation for radical cure should be immediately performed. In case the intestinal wall is broken down, or is so nearly necrotic that its return into the cavity of the abdomen is attended with danger of rupture of the gut and escape of its contents, two alternatives present themselves: to leave the intestine protruding and establish an artificial anus, or to exsect the dead portion and sew the ends together. If the patient is in good condition, and especially if in the prime of life and usefulness, exsection should be done. If, on the other hand, collapse is imminent, or if there is anything in the condition of the patient to contra-indicate a prolonged operation, a fæcal fistula should be established, and restoration of the alimentary canal should be postponed for a few days or even weeks.

In making a temporary fæcal fistula in a case of strangulated hernia, it is safest to stitch the bowel to the ring before relieving the strangulation. If, however, the intestine is very necrotic, the constriction should be relieved and the gut drawn out until healthy tissue is reached, and it should then be sutured. In determining when it is best to perform resection, it should be remembered that the longer the operation is postponed, the more contracted from disuse becomes the end of intestine nearest the anus.

Immediate resection of the bowel is performed as follows: Having released the strangulation as above described, both ends of the loop are

drawn out until five or six inches of sound gut are exposed. These may be grasped by the thumb and finger of an assistant close to the level of the abdominal wall, or, if the hand of an assistant would be in the way, a broad, disinfected tape may be tied loosely around each end of the intestine near the ring, to prevent the possibility of retraction or escape of the bowel or its contents inward. With sharp scissors the intestine is divided squarely across at each end of the limit of necrosis (at right angles to its axis), and a triangular piece is cut from the mesentery, the base of which corresponds to the section of intestine removed; it is very important, however, to leave the mesentery protruding at least one-eighth to one-fourth of an inch longer than the bowel, for fear of cutting off some of the blood supply to the latter near the mesenteric

Fig. 1731.

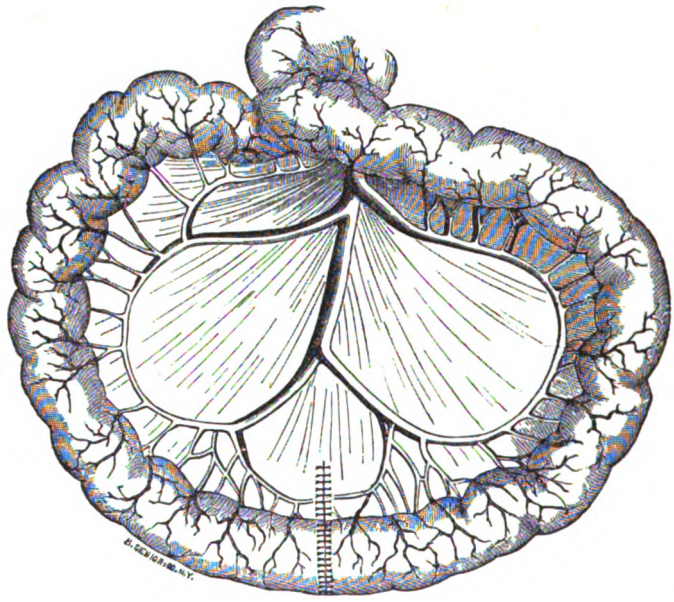


Resection of Intestine.

attachment. All bleeding points in the mesentery are ligated with catgut. In dividing the intestine with scissors, the line of incision should be well away from the necrotic tissue (Fig. 1731). The cavity of the gut from the tapes to the opening should be carefully emptied of all matter and thoroughly washed out with hot boric-acid solution for disinfection. The edges of the divided mesentery are united by interrupted sutures of fine silk, or of catgut which is known to be thoroughly sterilized. In uniting the ends of the divided gut it is advisable to use two forms of suture: (1) That which includes the mucous membrane alone (Czerny's suture); (2) that which includes the peritoneal coat alone (Lembert's suture). In Fig. 1733, which represents a longitudinal section through the ends to be approximated, the Czerny suture is shown at *b*, as it is passed through the mucous layer of the intestine from the inner surface of the canal; while at *a*, the method of introducing the Lembert suture through the peritoneal layer is shown. When a

gut is cut across, the longitudinal muscular layer retracts, carrying the peritoneal layer with it, and leaving the thick mucous membrane protruding about one-eighth of an inch. The object of the Czerny

Fig. 1732.



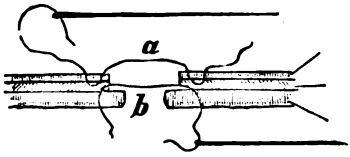
Resection of Intestine. The suturing completed.

suture is to bring the mucous membrane and connective tissue upon which it rests together, and thus strengthen the line of union after adhesion occurs.

If this is not done, the slight adhesions between the peritoneal surfaces obtained by the Lembert suture might give way under the strain of distention by gas or ingested matter.

The objection to passing a suture entirely through the wall of the gut, and thus approximating all the coats at once, is the danger that the perforation by the needle and suture may permit the escape of gas or toxic contents. The inversion of the mucous membrane by the Czerny suture, and of the peritoneal layer by the Lembert suture, after

Fig. 1733.



Czerny and Lembert Sutures.

Fig. 1734.

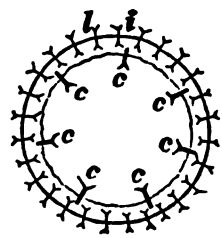
Czerny and Lembert Sutures; the threads tied.

the threads are tied, is shown in Fig. 1734. In suturing the intestine, the very finest silk and delicate half-curved needles should be employed. The silk should be made aseptic by boiling and by immersion in 1–2000 bichloride solution, from which it is taken as the needles

are threaded. Begin as follows: Insert one Czerny suture just at the mesenteric or attached border of the intestine and tie this, the knot of course coming within the lumen of the gut. The needle should pass from within through the mucous layer at a distance of about one-eighth of an inch from the free border (Fig. 1733), out at the junction of the mucous and muscular layers, and, being carried across to the opposite end it should be made to enter between the muscular and mucous layers and to emerge through the mucous layer one-eighth of an inch from its cut edge. A Lembert suture should be next inserted just at the edge of the mesenteric attachment as follows: The needle is made to enter the peritoneal coat one-eighth of an inch from the edge, and passing between the serous and mucous coats is again brought through the peritoneal layer about one-twenty-fifth of an inch from the edge (Fig. 1733). At a point exactly opposite, the same stitch is passed through the peritoneal layer of that side, the same distance and in the same way, and this thread is tied. In knotting all of these sutures it is a wise precaution to use the *double* or *friction* knot for the first tying, for by so doing there is no danger of the suture slipping and the parts separating as the second loop is being made. A second Lembert suture should now be inserted on the other side of the mesenteric attachment, and *care must be taken to see that the ends of the cylinder at the mesenteric attachment are in perfect coaptation.* It is my practice to insert one or two additional silk sutures into the mesentery on the outer and inner side surfaces, in order to be sure that perfect coaptation is secured.

The sutures are now inserted for the remainder of the opposing surfaces. The mucous or Czerny sutures should be from one-fourth to three-eighths of an inch apart; the Lembert sutures about one-sixteenth of an inch apart. The relative positions of these sutures are shown in Fig. 1735.

Fig. 1735.



Relative Position of Czerny and Lembert Sutures.

It is evident that while the Czerny suture is tied leaving the knot within the cavity of the intestine for the first part of the operation, the last few threads must be tied leaving the knot embedded between the mucous and muscular layers of the wall. In applying the sutures, the plan is, first a Czerny, then a Lembert nearly over this, then two or three other Lembert sutures, and then a mucous or Czerny suture, and so on. It is necessary to insert the Czerny suture before the superficial sutures. All of the threads should be cut off close to the knot. Properly applied, there can be no leakage in this coaptation of the bowel, and after a thorough cleansing and drying with sterilized gauze or sterilized iodoformized tufts, the loop of intestine may be dropped back into the bowel after the constricting tapes are removed.

Closure of the wound in the abdomen should be effected as advised after the operation for the radical cure of hernia.

In certain cases of intestinal resection, even after the sutures are all applied, it may not always be a safe procedure to drop the loop of intestine back into the peritoneal cavity and close the abdominal wound at once. In one case upon which I operated for the closure of a fæcal fistula in the ileum, in which about two inches of the intestine had to

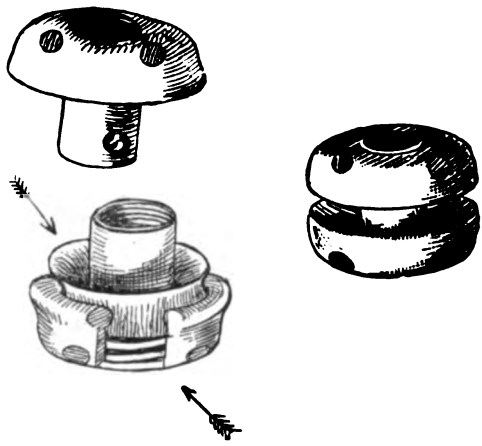
be resected, there was an impaction of fæcal matter in the large intestine which I could not remove by most careful irrigation through the fistula above and by the long rectal tube below. Knowing that great strain would come upon the sutures, with possible rupture at the line of union and destruction of my patient, I performed the following operation: On December 2, 1892, the intestine above and below the opening was plugged with tight-fitting sponges, and the intervening portion and the wound and integument about the wound were thoroughly cleansed. I carried an incision through the skin parallel with the margins of the opening and half an inch from its edge, making this elliptical incision about three inches long and one and one-half inches wide at the widest portion. The dissection was carried through the fascia, fat, and muscles toward the line of adhesion made by the row of sutures in the original enterostomy, so that when this was reached and the peritoneum opened the wound presented a bevelled edge, widest at the cutaneous surface.

The coil of intestine from which the fistula opened and one coil adherent to this were now brought through the wound, and iodoformized gauze was packed around the edges to prevent septic or foreign matter from getting into the peritoneal cavity. Tape were tied around the intestine eight inches above and below the opening, the sponges were removed from the gut, and the cavity was washed out with the Thiersch solution. By careful trial it was seen that if the fistula were closed by a row of longitudinal sutures, the lumen of the gut would be only one-third of its original size. I therefore, with sharp, straight scissors, cut through healthy intestine on either side of the opening and removed three inches of the gut, dividing it at right angles to its axis; a triangular strip of mesentery was also excised, taking care to leave the mesentery overlapping the end of the gut by at least one-fourth of an inch, so as to secure the vascular supply of the part involved in the operation. The method of suture was identical with that just described, care being taken to put in the additional sutures at the mesenteric attachment. In returning the united bowel to the abdomen a mat of iodoformized gauze, five inches wide and about eight inches long, was passed under the coil of intestine until it rested upon the mesentery, one end of this mat being brought out through the wound. A similar piece was inserted on the opposite side until it touched the mesentery exactly opposite the first piece. Tufts of iodoform gauze were placed upon the bowel for two inches on either side of the line of sutures until the level of the abdominal incision was reached. On the fourth day the gauze was all removed, and the isolation of the sutured intestine was perfect. It was held by adhesions and walled off from the general peritoneal cavity, and was about three inches below the level of the incision in the abdomen. On the eighth day, after considerable tenesmus and straining, one or two sutures at the line of union gave way, and fluid ingested matter escaped. This small opening closed spontaneously in eight days, and the patient recovered.

In reunion of the small intestine by the method just described, I have noticed that where a fæcal fistula has been established for some time (from ten days to six weeks), the intestine on the rectal side of the fistula is considerably smaller in diameter than the bowel above the opening. In one case of this character which also ended in recovery,

I left the space between the sutures on the upper end of the gut a little wider than on the lower (about a flush one-eighth of an inch on the upper side and a scant one-eighth of an inch on the lower), and was surprised to notice within a few minutes after re-establishment of the continuity that the intestine below expanded to a size equal to that above the line of union.

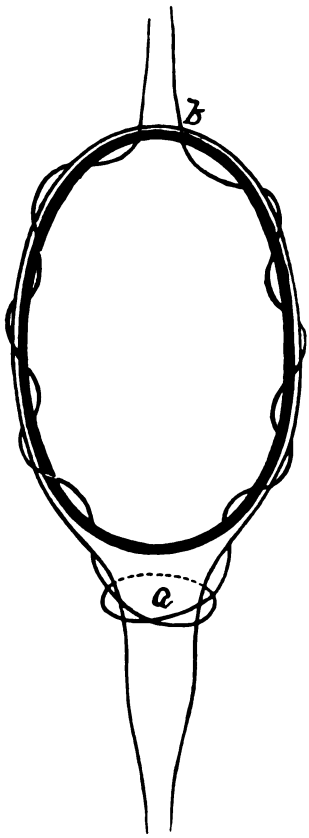
Fig. 1736.



Murphy's Button for Intestinal Anastomosis.

When the condition of the patient is such as to demand a more rapid procedure than union by suture, as just described (which in skilled hands will take at least one hour to perform), I would advise the employment of the Murphy button, a most ingenious device of Dr. J. B. Murphy, of Chicago (Fig. 1736). These buttons are made of various sizes to suit different portions of the alimentary canal. While they are more readily adapted to union by lateral anastomosis, and to the operation of cholecysto-enterostomy, they have also proved successful in end-to-end anastomosis, and in my opinion are the best appliance next in order to rapid suture. These buttons consist of two small circular bowls (Fig. 1736), so arranged that when properly adjusted in that portion of the bowel where the anastomosis is to be made they close together by a double ratchet, compressing the inverted peritoneal surfaces of the ends of the intestine, and securely holding these surfaces in apposition until adhesion occurs. The thread, which has tied the end of the gut around the central portion of each segment of the button and inverted the peritoneum, becomes loosened by necrosis from pressure, and with the button, in from seven to fifteen days, drops loose into the alimentary canal, and is carried along until it is passed with the fæcal matter through the rectum. At Fig. 1737 the method of passing the suture in and out around the margin of the bowel is shown. With a straight needle, armed with a medium-sized silk suture, the needle is carried through the bowel, a little more than one-eighth of an inch from its cut edge, passing through the peritoneal coat and into the lumen of the gut. One-fourth of an inch further on the suture is carried on the same level through the mucous

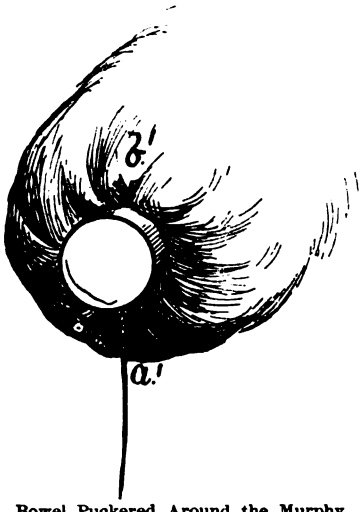
Fig. 1737.



Mode of Passing Suture to Secure the Murphy Button.

membrane and out through the peritoneum to the outside. It is then carried over the free (cut) edge of the bowel again to the inner side and through, and this in-and-over suture is continued (as shown in the drawing) until the bowel has been perforated by the needle from the mucous membrane side out to the peritoneal surface, just at the beginning of the attachment of the mesentery to the intestine. The suture is then carried over the cut edge of the mesentery around and back through the mesentery at the same depth from the edge as with the intestine, then back again over the cut edge of the mesentery, and on in like manner for the opposite side of the gut to a point of emergence about one-eighth of an inch from the point where it entered. The two ends of the thread are now ready for the insertion of one segment of the button. This is grasped by the forceps and is carried into the end of the bowel, deeply enough to allow the gut to be snugly folded around the central shaft or stem, when the two ends of the thread are tied into a single knot and are drawn upon. Like the mouth of a reticule that is being closed, the wall of the intestine is folded and puckered until it fits tightly around the central shaft of the button, as shown in Fig. 1738, when the knot is completed and the threads are closely cut off.

Fig. 1738.



Bowel Puckered Around the Murphy Button.

Examining this end of the bowel, it is readily seen that when the opposite half of the button has been in like manner applied, and has been pushed into this, there will be nothing but the peritoneal surfaces of the gut in contact. If the mucous membrane should become everted, or if the thread has not been so thrown over the mesentery as to invert this thoroughly, and bring the peritoneal surfaces in apposition, there will be failure of union, sloughing, and perforation at these points. The whole success of the operation rests upon the careful application of the button. The other half is applied in the same manner as the first, and then the two are brought together with the smaller invaginated into the larger. By pressing them steadily together they close until the peritoneal surfaces are snugly in contact, and the operation is completed.

In this operation, as in end-to-end suture, the greatest care must be taken to prevent any foreign substance from entering the peritoneal cavity. It is well to add that while a fair degree of success has already attended the use of this apparatus, it is at this date still on trial, though it is to be hoped that it may prove so efficient that its employment will become permanently established in the surgery of the intestinal tract. While almost any cool and careful surgeon can make an approximation by this apparatus, there are very few, comparatively, who have the experience or the skill necessary to do an end-to-end anastomosis by suture within a reasonable limit of time. It must not be forgotten, however, that a number of fatal cases have already

been reported as caused by the button not coming away, or by its lumen becoming closed, or by the intestines being occluded by its weight.

As to the comparative advantage between end-to-end and lateral anastomosis by bone or vegetable plates, catgut rings, or the segmented rubber ring, the preference should be for end-to-end reunion. When a lateral anastomosis does become necessary or advisable (a rare condition, in my opinion), I should prefer direct suture around the two openings to be joined, rather than any of the apparatus heretofore recommended for the purpose. When immediate excision and reunion are not advisable, and a secondary operation is undertaken, the manner of exposing the fistulous part of the gut, which has just been described, should be followed.

The question of walling off the part of the intestine operated upon should depend upon the condition of the intestine beyond that point. As a rule it is safer to wall the gut off, and thus prevent any possible danger of the sutures giving way, or of the intestinal contents escaping into the general peritoneal cavity.

One objection to this method is that it leaves a weak point in the abdominal wall, as the wound must be allowed to close by granulation. Should ventral hernia result it can be subsequently closed by operation. When there is the least doubt as to the integrity of the line of sutures in the gut, I should advise the open method.

When it is desired to establish an artificial anus, the strangulation should be relieved as already directed, and the bowel should then be incised. In the course of a few days, when the patient has fully recovered from the effects of the strangulation and of the operation, the canal may be restored by opening the abdomen, exsecting the protruding intestine, and uniting the ends by suture as already described; or the operation of Dupuytren may be undertaken. This consists in gradually breaking down the promontory formed by the contiguous walls of the incarcerated loop, and, when this is done, allowing the external wound to close by granulation. The instrument used in this operation is in shape not unlike a pair of forceps, with flat, roughened jaws, and with long handles which can be locked by a clamp. The jaws are introduced at first for a slight distance only, one going into the ascending and the other into the descending part of the loop of intestine, when they are closed and clamped in such a manner that the walls of the promontory are held firmly in contact.[1] The instrument is allowed to remain in position. Adhesion occurs in the contiguous peritoneal coverings of the gut, while that part of the promontory which is firmly grasped by the instrument sloughs away. This procedure has been successful in a sufficient number of cases to justify its employment. If a cure is not effected, or if stricture should result, subsequent exsection should be performed.

Inguinal hernia in the *female* has the same relation to the epigastric vessels as in the male subject. In the complete form the contents may descend into the labium. The treatment does not differ materially from that already described. The radical operation is simpler than in the male for the reason that the spermatic cord is not involved, and the hernia is more readily cured. Cysts of the canal of Nuck not infre-

[1] See Fig. 1206, Vol. V., page 581, *supra*.

quently simulate hernial tumors; or, as before said, the ovary, and rarely the Fallopian tube, may be in the canal.

DIAGNOSIS AND TREATMENT OF FEMORAL HERNIA.—This form of hernia is more difficult to retain in place with a truss, which apparatus produces more discomfort also than when worn for inguinal hernia. It is more likely to become incarcerated and strangulated than any other variety, and its *prognosis* is, therefore, more unfavorable. The *diagnosis* depends upon the presence of a tumor in the location already described, the neck of the tumor being traceable to an opening at the inner side of the thigh, just external to the spine of the pubis, and below Poupart's ligament. The impulse in coughing is present, though usually less perceptible than in inguinal hernia. Cysts are less apt to complicate a femoral than an inguinal hernia. Enlargement of the lymphatic glands will not be apt to mislead, since there will have been a history of adenitis and a gradual increase in the size of the glands, which may be recognized as a group. The absence of impulse in the act of coughing will further aid in the exclusion of hernia.

The symptoms of strangulation differ in no essential features from those in inguinal hernia.

A *reducible* femoral hernia should be retained within the abdomen by a truss, the pad of which presses firmly over the femoral ring, just external to the spine of the pubis. The pad should be hard and small, so that it may not compress the femoral vein, and the spring should be strong, for this form of hernia is not only difficult to retain, but is doubly dangerous when it escapes by the side of the pad. In reducing femoral hernia, *position* is invaluable, and *taxis* may be of aid. The best position without taxis is the knee-shoulder posture, in which the abdominal muscles and fascia lata are relaxed, and in which the contents of the abdomen gravitate toward the diaphragm. Or the dorsal decubitus may suffice, with the pelvis elevated as well as the foot of the bed, and with the thighs flexed upon the abdomen. In performing taxis, it must be remembered that the bulk of the hernia must pass directly backward to clear the falciform process of the fascia lata, and then upward in the direction of the femoral canal. The nature of the operation for the *radical cure* of femoral hernia may be determined by the general rules given for the inguinal variety. If the sac is large a portion of it may be cut away, the remainder being carried to the inner aspect of the abdominal wall near Gimbernat's ligament, and being anchored there in the same general way as described for the treatment of the sac by the Macewen method. In the effort to close the femoral ring, kangaroo-tendon and next in order silk sutures are preferable, and care must be taken to avoid the femoral or iliac vein which is almost in contact with the hernia at the outer edge of the crural canal. In irreducible (not strangulated) femoral hernia operative interference is more positively indicated than in inguinal hernia, from the fact that strangulation is very apt to occur, and that the employment of a compress to prevent a further descent of the mass is harmful.

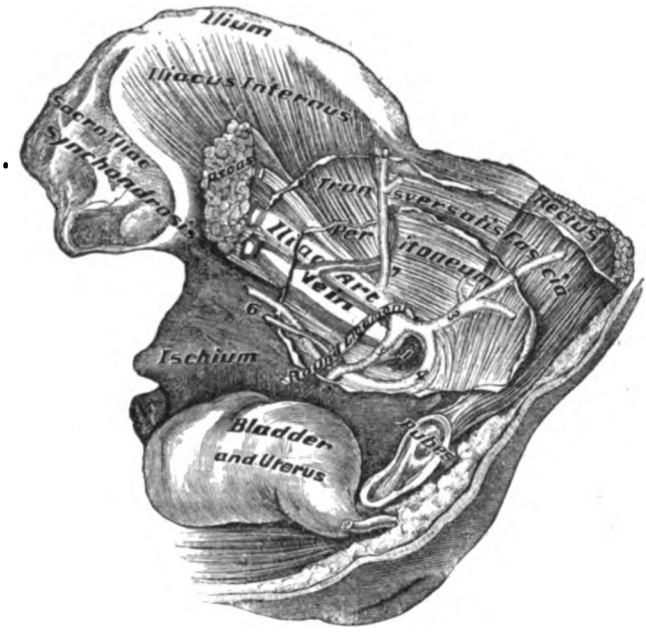
In *strangulated* femoral hernia operative interference is indicated immediately upon the first manifestation of this condition. So rapid are the changes which occur in the contents of the sac, that early operation, always commendable in every form of strangulated hernia, is im-

perative in the variety under consideration. Taxis should not be attempted until the patient is fully anæsthetized.

The preparations for operation are identical with those for inguinal hernia. The most thorough shaving of all the integument near the operative field is essential. When narcosis is complete, the patient should be lifted by the legs in such a way that the thighs will be flexed upon the abdomen and the pelvis raised considerably higher than the thorax. While in this position taxis, in a direction at first slightly backward and then upward, should be practised. If reduction is not effected in from five to ten minutes it should be discontinued.

The incision should be longitudinal in direction, along the middle of the tumor, with its centre over the femoral ring. The length will vary

Fig. 1739.



Femoral Hernia. 1, femoral opening; 2, normal position of obturator artery; 3, epigastric artery; 4, abnormal and dangerous position of obturator artery arising from the epigastric.

with the size of the protrusion, but three or four inches will usually suffice. It should be made by cutting directly down upon the sac, and when this is reached the dissection should be continued between two dissecting forceps. As the sac is punctured a few drops of fluid will escape, and a grooved director may then be inserted, the opening carefully enlarged until the index finger can be introduced, and this carried upward until the edge of the falciform process is felt and the nail is under the sharp constricting edge of Gimbernat's ligament. At this stage of the operation the hernial sac should be carefully irrigated with a 1–5000 bichloride solution or with a hot boric-acid solution. The hernia must now be kept between the finger and the femoral vein, with the edge of the nail against Gimbernat's ligament, just at its insertion into the os pubis. I have frequently been able, by scratching with the nail and firm pressure with the end of the index finger, to tear or

stretch Gimbernat's ligament at this point enough to relieve the strangulation, and to effect reduction without the use of the bistoury; however, if this cannot be done, a long, probe-pointed knife should be carried flatwise along the palmar side of the finger, with the cutting edge directed toward the median line. The constriction is relieved by lifting or scraping the attachment of Gimbernat's ligament from the os pubis, and in doing this the cutting edge of the knife should not be carried beyond this ligament, nor should it have any other direction than inward toward the symphysis. If these precautions are not observed, a dangerous complication may arise in the division of the obturator artery (or vein) in cases in which it is derived from the epigastric branch of the external iliac. In eight fatal cases of this character recorded, the patients were all females. This abnormal derivation occurs in women in nearly fifty per cent. of cases, as determined by myself in a study of this artery in both sexes, and in twenty-five per cent in men; while the vein arches over the femoral ring in a still larger proportion of cases.[1]

The manner in which the artery arches over the crural ring is shown in Fig. 1739. When the strangulation is relieved, the contents of the sac are returned into the abdomen.

UMBILICAL HERNIA.—The *diagnosis* between this form of hernia and other tumors of the umbilical region will depend chiefly upon the impulse conveyed to the hernia in the act of coughing, or in crying in children. If the hernia is made up of omentum—and this is not uncommon in adults—it will be doughy to the feel, and flat or dull on percussion. Intestine will be more or less resonant. If the mass is reducible in the recumbent posture, and under direct manipulation, the diagnosis of hernia is evident. A cyst of the omphalomesenteric duct would be translucent, and fluctuation would be present. In congenital hernia, the extreme thinness of the covering renders the recognition of the character of the tumor easy. The transverse colon often descends into the sac of an umbilical hernia.

Treatment.—In *congenital* hernia at the navel, which is covered only by the thin membrane of the cord, the tumor should be returned at once. The margins of the aperture through which it has escaped should then be pared, and the opening closed by carefully adjusted silk sutures, supported by adhesive strips drawn in dove-tail fashion across the abdomen at the weak point, or by a firmly rolled bandage. If covered over with integument the hernia should be reduced, and a small, firm compress laid over the opening and secured in place by adhesive plaster applied as just described. The *acquired* form is treated in the same general way. In reducing umbilical hernia a recumbent posture, with the legs slightly flexed, is advisable, and careful taxis is often necessary. A truss should be worn when in the upright posture, and even at night when the patient is suffering from cough. In mild cases a light rubber belt will suffice after retiring, but the heavy apparatus should be adjusted before leaving the recumbent posture.

Irreducible hernia, not strangulated, may be held in position by a properly adjusted cup-shaped compress.

The danger of strangulation is always present, and the advisability of

[1] Wyeth, Essays in Surgical Anatomy and Surgery. New York, 1878.

an operation must be determined by the circumstances of each case. On account of the great thickness of fat in some of these subjects, and the enormous size of the hernial mass, the operation for radical cure, when the hernia is not strangulated, becomes formidable, and when strangulation is present, is accompanied by more than ordinary danger. In operating for radical cure the sac should be divided along the edges of the opening. The edges should be drawn up and pared with scissors, and the aperture should be closed by strong sutures of silk including skin, fascia, muscle, and the peritoneum of the abdominal wall, the needle piercing this last tissue about one-fourth of an inch from the pared edge. As the sutures are tightened, the opposing surfaces of the parietal peritoneum of the two edges will be united.

With the first symptoms of strangulation the patient should be anæsthetized, and a careful effort at reduction made by the application of taxis. If this does not succeed, the operation should be performed at once. The incision for a small hernia should be longitudinal, with its centre corresponding to the neck of the sac. When the mass is large a double elliptical incision may be made, as there is a redundancy of skin and fat which may well be dispensed with. On account of the exceeding thinness of the integument at times over the hernia, great care should be exercised in cutting down upon the tumor. As soon as the sac is punctured a dull director is introduced, and the sac is divided sufficiently to allow the introduction of the finger, upon which the further division is effected. If the finger nail can now be insinuated between the neck of the hernia and the constricting ring, this should be done, holding the palmar aspect of the finger toward the pubes. A probe-pointed bistoury is introduced flatwise and guided along the finger, and the constriction is divided for not more than one-fourth of an inch at first, the direction of the cut being in the median line and downward. Or, if more convenient to the operator, this incision of the neck of the sac may be made in the upper aspect in the median line.

The management of the strangulated bowel or omentum should be the same as advised for inguinal hernia. I prefer to cut the sac away, as above advised, freshen the edges of the opening, and bring all the layers which compose the abdominal wall together with one set of sutures. Where large masses of changed omentum are found in these herniæ, they should be tied with clean catgut ligatures in sections, not including more in the grasp of each ligature than would represent the ordinary little finger of the hand. It sometimes takes as many as six or eight sets of ligatures to completely remove the mass. The omentum should be divided about one-fourth of an inch external to the ligature, and when all is cut away the stump is dropped back into the abdominal cavity. It is my practice, as soon as reduction is effected and before the sac has been cut away around the margin of the ring, to introduce a pad of sterilized gauze (secured by a string so that it may be withdrawn), taken out of hot Thiersch solution or hot sterilized water, and laid over the intestines immediately beneath the opening. When the sutures have all been inserted, and are ready for tying, the pad should be withdrawn.

OTHER FORMS OF HERNIA.—*Ventral hernia* is amenable to the same general treatment as hernia of the acquired umbilical form. In opera-

tion for the cure of hernia following the incision of laparotomy, the same method would suffice. In one of my cases the recti muscles, during violent straining at parturition, were split apart from a point three inches below the xiphoid cartilage to within an equal distance of the pubis. At least two-thirds of the intestinal contents were prolapsed into this enormous hernia. An elliptical incision throughout the extent of the tumor was made, and closure was effected by silk sutures, following the method described for umbilical hernia. A perfect cure was effected.

In *diaphragmatic hernia* the diagnosis must be based upon the symptoms of obstruction. Pleuritis will be present in a varying degree. When this accident is suspected, and symptoms of obstruction are present, it is imperative to make a median incision below the xiphoid cartilage, when by exploration with the hand the hernia may be reduced by traction, with or without dilatation of the opening in the diaphragm. The prognosis in these cases is unfavorable if operative interference is delayed.

The recognition of *gluteal hernia* is also difficult. If with the symptoms of obstruction there is pain in the region of the sciatic notch, or in the distribution of the gluteal or sciatic nerves, and increased by direct pressure, the presence of gluteal hernia may be suspected. If a tumor can be made out, the diagnosis is still more positive. To locate the notch, place the patient on the belly and hold the leg perfectly straight, with the toes pointing directly downward. A line drawn from the posterior superior spine of the ilium to the upper surface of the great trochanter will cross over the foramen.

The incision should be free, the fibres of the gluteal muscles being separated by the finger. The vessels should be located before the constriction is divided.

Obturator hernia may be present without any appreciable tumor. It may be recognized by digital exploration through the rectum or vagina. Pressure upon the obturator nerve may produce pain in the hip or knee. If the symptoms of obstruction are present, the hand should be introduced through an incision in the linea alba, when, by careful exploration of the pelvis, the character of the lesion can be determined. In an effort at reduction by traction from within, the thigh should be rotated outward to relax the obturator muscle. If necessary an incision may be made immediately over the foramen, when the constriction may be divided from below. When the fibres of the pectineus muscle are divided, the tumor will be encountered.

Lumbar, *vaginal*, and *pudendal* herniæ do not demand especial consideration. The diagnosis will depend upon the appearance of the tumor, with the symptoms of strangulation when the constriction is sufficient. The return of the mass which follows prolapsus of the uterus into the vagina, may be effected by direct reposition of the uterus, or by conjoined manipulation with one hand introduced through an opening in the linea alba.

HERNIA IN CHILDREN should be treated in the main as advised for adults. On account of the inability of children to control themselves, a diagnosis is attended with some difficulty and is, as a rule, determined by the impulse imparted to the hernial mass as the child struggles and

cries. The hernia is usually reducible when the child is held with the head downward, by gentle taxis over the tumor. It is very essential that an effort should be made to cure the herniæ of children by proper application of, and careful attention to, the truss. The hard pad (celluloid) of the Hood pattern, as recommended by Dr. S. E. Milliken, is light and easily adaptable, and can be kept clean.

The truss should never be removed from its point of pressure except by the physician or by a nurse who has been carefully instructed in its application and use. In healthy children a cure is often effected within two or three months. In others it may be impossible to effect a cure. The importance of good feeding will be appreciated in this class of cases as in all others. If strangulation should occur, it should be relieved by operation at once; and in cases where a cure cannot be effected by the truss, and where the tumor is not readily retained by this apparatus, an operation for the radical cure should be performed. It is better to operate about the fourth or fifth year. The same operation as advised for adults is admirably adapted to these cases. It is my rule, after the operation, to put children in the plaster-of-Paris spica at once, in order to ensure the recumbent posture. In all operations about the genital apparatus of children the iodoformized collodion dressing is recommended, because it hermetically seals the wounded surface and prevents infection from urine or other sources.

INTESTINAL OBSTRUCTION.

BY

JOHN ASHHURST, JR., M.D.,

BARTON PROFESSOR OF SURGERY AND PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF PENNSYLVANIA, SURGEON TO THE PENNSYLVANIA HOSPITAL, ETC.

THERE is not a great deal to be added to the original article on "Intestinal Obstruction" in Vol. VI. Surgeons still are divided into two camps as to the treatment of this condition, some maintaining that it is right to operate in haste and make a diagnosis afterward at leisure, while others, and I should be glad to think an increasing number, believe, as I certainly do, that the diagnosis should be made first, and that it is not justifiable to open the abdominal cavity without having at least some idea of what is likely to be found amiss, and some reasonable hope of being able to remedy what is wrong. Again, it is still almost impossible to persuade the public, and indeed many practitioners, that there can be more than one cause for obstruction of the bowels, to wit, impacted fæces, and hence we constantly find patients brought to the last stage of exhaustion by the injudicious administration of purgatives before any suspicion is excited that a condition may be present for which purgatives can only do harm.

INTUSSUSCEPTION.

The most interesting and important addition which has been made to our knowledge of intussusception is the strong plea which has lately been advanced by Mr. Jonathan Hutchinson—a surgeon whose opinions are always to be listened to with the highest respect—in behalf of systematic kneading and manipulation, which he calls *abdominal taxis*, in the management of this affection. He records a number of cases in which this mode of treatment proved successful, and urges that taxis for intussusception should be regarded as presenting equal claims to those of the taxis for ordinary strangulated hernia. I have had one opportunity of putting Mr. Hutchinson's recommendations in practice, and in that instance with most satisfactory results:—

The patient was a man in the Pennsylvania Hospital, under the care of my colleague, Dr. Morris J. Lewis. He had been ill for several days with great abdominal pain, tenesmus, and straining, with constipation, and a tumor in the left flank. The rectum was extremely tender, but there was no discharge of

bloody mucus. By digital examination I felt the rounded end of an intussusceptum, forced down against the finger when the patient strained, and receding when his abdominal muscles were relaxed. There was not much tympany, and I was able fairly well to grasp the tumor externally with both hands, and under a kind of conjoined manipulation—increasing and relaxing the pressure with either hand alternately—it gradually disappeared with gurgling and borborygmus, and the patient professed himself instantly relieved. He had no further bad symptoms; the bowels moved spontaneously in due time; and the man left the hospital in a few days entirely convalescent.

Were every case of intussusception as amenable to treatment as this one proved to be, there could be no question that abdominal taxis would be the proper remedy to be adopted; but unfortunately, in the majority of cases, by the time that the diagnosis is made, more or less firm adhesions have already formed, and the necessary manipulations are then on the one hand little likely to be successful, and on the other hand not unattended with danger from the possibility of causing rupture of the weakened bowel and consequent fatal peritonitis. Hence it seems to me that the taxis should only be attempted in the early stages of intussusception—for instance, during the first four days—or in those comparatively rare cases, such as that above narrated, in which the absence of bloody and mucous discharge shows that the disease is only subacute in character. When the symptoms show that the invaginated part is very tightly grasped, and when the duration of the case renders it probable that adhesions have already formed, it is, I have no doubt, safer to place the patient under the influence of opium, and await the possibility of cure by the spontaneous separation of the intussusceptum.

Enterotomy for Acute Obstruction.

In cases of doubtful diagnosis, or in which for any reason the more formidable operation of laparotomy is not thought advisable, *enterotomy*, as practised by Nélaton and Bryant, will often afford relief, and may sometimes prove curative. Instead of establishing a false anus, which in the upper part of the small intestine is objectionable, as depriving the patient of the digestive function of a considerable portion of the bowel, it has been recommended that the segment of gut which it is intended to open should be brought out of the abdominal cavity and packed around with iodoform gauze, and that after making the incision this should be kept patulous by the introduction of a large drainage-tube, or otherwise, the surgeon sitting alongside of the patient for several hours if necessary, and encouraging the escape of fæcal matter until the replacement of abdominal distention by flaccidity shows that the contents of the bowel have been thoroughly evacuated, when the wound may be sutured and the intestine restored. It would, however, I think, be safer in most cases, after carefully emptying the bowel in the way described, to leave it unclosed for a few days at least, with its opening outside of the abdominal cavity, and not to attempt restoration of the natural channel until it was found that the symptoms of greatest urgency had passed by. According to Dr. B. F. Curtis's statistics the mortality of enterotomy is about fifteen per cent. less than that of abdominal section.

LAPAROTOMY.

It has been urged by Mr. Davies-Colley and Dr. R. P. Harris that the term *laparotomy*, which from its derivation strictly means an incision into the lateral portion of the abdomen, or the flank, should be abandoned and should be replaced by cœliotomy, from the Greek word κοιλία (signifying, *inter alia*, "the belly") and τέμνω ("I cut"). But, as a matter of fact, κοιλία is also used by Hippocrates for the cavities of the lungs and for the sockets of joints, by Aristotle for the ventricles of the heart, and by Galen for the fleshy parts or "bellies" of muscles; so that whatever charge of inaccuracy may be brought against "laparotomy," as applied to a median operation, its proposed substitute seems to me still more objectionable on account of its indefiniteness; and the former term, having been adopted into surgical literature in all civilized countries, may well be allowed to remain.

The statistics of laparotomy for intestinal obstruction continue to grow, so that to the 346 cases tabulated in Vol. VI.,[1] I was, in the sixth edition of my "Principles and Practice of Surgery,"[2] enabled to add 279 more, giving a total of 625, of which nearly two-thirds appear to have terminated fatally. The mortality is still greatest in cases of intussusception, and I see no reason for changing the opinion previously expressed that operation is as a rule best avoided in dealing with *acute* invagination; in *chronic* cases (which are very rare) laparotomy may be called for, and in cases of acute obstruction other than intussusception, it often affords the only hope of recovery. The annexed table, similarly arranged to that in Vol. VI.,[3] shows the results of the operation in the 625 cases referred to.

TABLE SHOWING THE RESULTS IN SIX HUNDRED AND TWENTY-FIVE CASES OF LAPAROTOMY FOR INTESTINAL OBSTRUCTION.

NATURE OF OBSTRUCTION.	Cases.	Result not ascertained.	Recovered.	Died.	Mortality per cent. of terminated cases.
Intussusception	133	27	29	77	72.6
Volvulus, etc	53	1	16	36	69.2
Strangulation persisting after herniotomy or taxis	30	..	10	20	66.7
Foreign bodies, impacted fæces, gall-stones, etc	43	1	16	26	61.9
Tumors, strictures, ulcers, etc	72	5	25	42	62.7
Strangulation by bands, adhesions, diverticula, etc	199	4	74	121	62.0
Various forms of hernia and "ileus"	45	1	18	26	59.1
Other forms of obstruction	13	..	5	8	61.5
Not ascertained	37	1	13	23	63.9
Aggregates	625	40	206	379	64.7

With regard to the *technique* of the operation, it may be said that too much stress cannot be laid upon the importance of preventing the patient from becoming chilled, of avoiding unnecessary protrusion of the omentum and bowels, and of economizing time during the whole procedure. Only very weak antiseptic solutions, if any, should be em-

[1] Pages 69–76. [2] Page 923. Philadelphia, 1893. [3] Page 69.

ployed within the abdominal cavity, it being indeed safer to rely upon flushings with warm distilled water. Whatever view may be taken as to the necessity of drainage in abdominal surgery generally, there can, I think, be no question that it is desirable after laparotomy for obstruction of the bowels, and the glass drainage-tube is, I think, in these cases preferable to that of india-rubber. It should be furnished with a rubber dam and a tent of sterilized gauze or cotton, so that the tube may be accessible without disturbing the general dressing. For suturing the external wound, silk-worm gut is now commonly preferred to silk, and the stitches should be made to embrace all the tissues, including the peritoneum.

Colotomy.

Though the statistics of lumbar colotomy appear still to be better than those of the inguinal operation, it cannot be denied that there is a growing feeling in the professional mind in favor of the latter procedure. Littre's operation is certainly simpler and more easy of execution than Amussat's, and has very generally been chosen in cases of congenital deformity, in children; and in view of the lessened fear of peritonitis with which surgeons now approach operations on the abdominal cavity, it is probable that it will hereafter be the operation of election in adults also. Colotomy in any form is adapted to the treatment of chronic rather than of acute obstruction, and I am more and more disposed to limit it to cases in which actual obstruction is either present, or at least impending. I have seen so many patients who after a successful colotomy were dissatisfied with their condition and would rather have returned to their previous state than continue to endure the annoyances of an artificial anus, that I am not disposed to urge the operation as long as defecation *per vias naturales* continues to be practicable. When the inguinal method is chosen, and immediate relief is not imperative, it is desirable to divide the operation into two stages, exposing the bowel and securing it to the abdominal wall on the first occasion, and postponing the incision of the gut until forty-eight hours afterward.

Enterectomy and Colectomy.

When it becomes necessary, after a laparotomy for intestinal obstruction, to excise a portion of either the small or the large intestine, it is best, unless the lesion be high up in the lesser bowel, to attach the ends to the margins of the external wound, so as to establish temporarily a false anus, which may afterward be closed when the patient is in a better condition for a prolonged operation. If, however, the lesion be in the jejunum or upper part of the ileum, nutrition would be so much interfered with by this course that it is then better to resort to immediate enterorrhaphy if the patient's condition will at all permit of doing so. The advice given in Vol. VI.,[1] that after intestinal excision a triangular piece of the mesentery, corresponding in length to the portion of bowel removed, should also be exsected, must

[1] Page 88.

in the light of further experience be revised. To do so interferes so materially with the circulation in the adjoining parts of the intestine as to endanger sloughing of the resected extremities; it is safer merely to cut the mesentery in the line of its attachment to the gut, and ligate it in sections to prevent hemorrhage, then allowing it either simply to pucker up, or folding it gently upon itself. To the 186 cases of enterectomy and colectomy tabulated in Vol. VI.,[1] I have been able to add 151 since recorded, the whole 337 giving 187 recoveries and 137 deaths, the result in 13 being unknown. The mortality of determined cases is therefore somewhat over forty-two per cent.

Circular Enterorraphy and Lateral Anastomosis.

When it is resolved to attempt restoration of the continuity of a resected bowel, either as an immediate sequel to enterectomy or for the relief of an artificial anus, the surgeon has two operations to choose from, viz., end-to-end suture (*circular enterorrhaphy*) and the procedure introduced by Professor Senn and very variously modified by other surgeons, and known as *lateral anastomosis*. The objections to the first-named operation, as formerly practised, were the time consumed in its performance, which sometimes seriously prejudiced the prospect of recovery, and the difficulty of obtaining close and accurate adjustment; hence the introduction of Professor Senn's method was hailed, and justly so, as furnishing a plan which could be easily and quickly executed, and which satisfactorily guarded against the risks of fæcal extravasation. As originally practised, this method consisted in approximating the sides of the two portions of bowel by plates of decalcified bone, previously introduced, and armed with ligatures which were carried through the intestinal walls and were tied together so as to hold these firmly in contact. The walls were then incised through fenestræ in the plates, so as to establish an anastomotic channel for the intestinal contents, and the ends of bowel were separately and carefully closed with sutures. The boneplates ultimately became softened and dissolved, and spontaneously disappeared.

Various substitutes for the decalcified boneplates have been employed by other surgeons, Penrose, Brokaw, Ashton, and Baldy using india-rubber, Stamm cartilage, and Robinson rawhide. Extemporized plates of raw potato and turnip have been used by Dawbarn and Von Baracz. Sachs has employed bone plates clamped together in the form of a perforated shirt stud, and Murphy uses perforated metal buttons, provided with a concealed spring to keep them closely approximated after adjustment. Abbe, Weir, and Halsted, on the other hand, dispense with all intra-intestinal devices, and practise anastomosis simply by making a long incision (about four inches) through the portions of gut to be approximated, and holding them together with stitches, Abbe employing a double row of continuous sutures, but Halsted preferring a quilt suture. When lateral anastomosis is resorted to, Abbe's suggestion is of value, that the portions of bowel should be adjusted with their ends pointing in opposite directions, so that the peristaltic wave may be continuous through both.

[1] Page 89.

As I have already remarked, Senn's operation was rightly looked upon as a decided improvement upon end-to-end suture as formerly practised, but it has not proved entirely satsifactory, and surgeons are, I think, again looking to a modified form of circular enterorrhaphy as a preferable method. The difficulty of close adjustment has been in a great measure overcome by an ingenious device of Maunsell, who invaginates both cut ends through a slit in the larger segment, sews them together accurately in this position, and then draws them back into place, closing the slit with a separate suture. To avoid the trouble which sometimes arises from the different calibre of the two portions of intestine, *oblique*, instead of circular, enterorrhaphy is employed by R. T. Morris, Connell, and other surgeons. Finally, Murphy's buttons may be equally well employed for end-to-end as for lateral approximation, and if further experience shall confirm the reports heretofore made as to their efficiency and safety, in their use will, I think, be found the best means of restoring the continuity of a resected bowel.

DISEASES OF THE RECTUM AND ANUS.

BY

CHARLES B. KELSEY, A.M., M.D.,

PROFESSOR OF DISEASES OF THE RECTUM IN THE NEW YORK POST-GRADUATE MEDICAL SCHOOL AND HOSPITAL, LATE PROFESSOR OF DISEASES OF THE RECTUM IN THE UNIVERSITY OF VERMONT, ETC.

THE advances in our knowledge and the changes in our treatment of diseases of the rectum in the last decade have been most marked in the graver affections and the surgical operations for their relief. New methods in the treatment of the more common diseases such as hemorrhoids and fistula are brought to notice from time to time, and make for themselves a permanent place in practice, or are forgotten, according to their merits. Such it is not our object to consider.

COLOTOMY.

Perhaps the most radical step forward in the surgery of the rectum since the earlier volumes of this work appeared, has been the acceptance by most of the profession of the teachings of Mr. Bryant regarding colotomy in bad cases of non-malignant ulceration, stricture, and extensive destruction of the parts by fistulæ. He was the first, I think, to appreciate the limits of the ordinarily employed methods of treatment in these grave cases, and to boldly advocate and still more boldly practise this operation, after the failure of dilatation, incision, and all the other time-honored and inefficient means usually resorted to. He was also the first to appreciate that a patient was much more comfortable and much better off with a well-formed anus in the loin, through which he might have one painless evacuation daily, than with a hopelessly diseased anus in the perineum which was a constant source of suffering and which could not be cured. Well do I remember, after weeks of treatment and two useless operations for old fistulæ and simple ulceration in an important patient, when I had made up my own mind that nothing but colotomy could do him any good and that without colotomy he would die, the comfort with which I read again Bryant's original teachings on this point. They seemed very bold to me then, but I have adopted the treatment recommended many times since with the happiest results.

The truth is that one must know from experience how very comfortable a patient with an artificial anus may be, before he can justly ap-

preciate the indications for the operation. To those who believe that the condition is a living death, that the patients are objects of disgust to themselves and those with whom they come in contact, and that there is a constant leakage of fæcal matter from the opening which prevents anything approaching personal cleanliness, it is useless to attempt to argue for the operation. But to such it will perhaps seem strange that many of the patients upon whom I have operated have themselves come to me and requested me to do so, because they had known and compared notes with others upon whom I had operated before.

One of my patients is a physician doing a large practice as a specialist in rectal diseases. Three years ago he came to me worn out with a simple ulceration high up in the rectum, and I did a colotomy. He has sent me several cases since, and they merely ask to be made as well and comfortable as he is, in the same way.

I think that few have started with a deeper natural objection to the operation than myself. At first I advised it with fear and trembling, but now I do so with perfect confidence.

To return, however, to the main point, the indications for the operation. A distinction must be made in all cases between ulceration and contraction. The latter is more easily overcome than the former. Ulceration kills in one way, contraction in another. Both may be associated in the same patient, or either may exist separately and may call for colotomy. Given a case of old, non-malignant ulceration, with or without fistulæ, and with no stenosis that prevents the patient from relieving his bowels with some straining daily, I often, in such a case, at clinical lectures, pick out some intelligent student and ask him what he would do, bearing in mind the fact that the patient has come from a long distance for relief, that he has been under treatment by one means or another for years, that he has spent all his money and can no longer work, and that he has grown steadily worse and is nearing the end of his suffering.

Generally the first answer is to dilate or to incise; and I point out that though the man has stricture, he is not really suffering from stenosis but from ulceration. Then local applications and antisyphilitic treatment are suggested; and again I point out that he has had four or five years of that treatment, that he has been filled with iodine and mercury, though the ulcer was never syphilitic but due perhaps to the sloughing following injections of carbolic acid into hemorrhoids, and I ask if with this past history it is worth while to continue the same treatment, pointing out that ulceration of such extent and with such an amount of destruction is incurable by local measures. Then it is seen that we must either leave the patient to die of his disease or do something more radical, and generally we choose colotomy, knowing that after the rectum has once been relieved of the irritation of the fæces it will heal after a few months without local treatment.

Inguinal Colotomy.

Still another advance of the past few years has been, I cannot but think, the general substitution of inguinal for lumbar colotomy.

The old operation was a good one, but, to my mind, the new one is

much better. Bryant with his large experience still holds to the old, most others prefer the new. The truth is, there are few operations in surgery apparently as simple as the formation of an artificial anus, and yet in which the skill and experience of the operator tell for as much in the subsequent comfort of the patient. Almost anybody can make an artificial anus; but not everybody can make one that shall be a comfort and not an additional annoyance to the bearer. Bryant gets good results from the lumbar incision and thinks it in every way preferable to the inguinal. I have never performed it, never having had a case in which I did not prefer the other, though I can imagine that such a case might occur—one, for instance, of intestinal obstruction from stricture of the rectum in which there was so much distention of the abdomen by gas that an incision into it would cause a practical evisceration, with the danger of having to puncture or incise the intestines before they could be replaced. The distention in such a case, which would render the anterior operation much more difficult, would only render the lumbar operation easier by pushing the descending colon into the incision.

To my mind the great advantage of the anterior incision, and one more than counterbalancing all the supposed advantages of the posterior, lies in the fact that the patient can care for an opening which he can see and reach, more easily than he can for one in his back; and I find no disadvantages in the inguinal operation to offset this palpable advantage. The dangers of incising the peritoneum, of having to search for the sigmoid flexure, or of extravasation into the peritoneal cavity when the gut is incised, have been, according to my experience, exaggerated. Patients thus operated on nearly all do well, and when any danger arises it is not one that could have been obviated by making the incision somewhere else. I have had to search a few moments for the sigmoid flexure through the abdominal opening, but similar delay often occurs with the lumbar method. In almost all cases the loop desired lies under the finger when the peritoneum is incised.

And yet I have had some curious experiences with this operation, and it may be said that no one can know exactly what he is to meet with when he begins it. For instance, in more than one case, although there has been no difficulty in putting the finger on the coil of gut wanted, there has been difficulty in raising it to the surface of the abdomen and stitching it there, on account of a short mesentery. Normally there should be a free mesentery to all parts of the sigmoid flexure, but abnormalities in this part of the gut are very common, and the absence of a mesentery seems not infrequent. Such a condition renders the operation much more difficult, but I have never known the obstacle to be insuperable, nor have I failed in the end to get a good and useful anus on this account.

In one of my cases I stitched the transverse colon to the incision, not because of a short mesentery, but because of the amount of cancerous infiltration which made me prefer to avoid that part of the bowel. It would have been no better with the lumbar incision, however, as the same condition existed all along the descending colon.

In another of my cases I met with a peculiar complication, which could not well have happened in the lumbar operation to be sure, but which was not a danger to be anticipated. The operation was done ex-

actly as usual, the silver-wire button-suture being passed under the gut.[1] At the time of operation the man was suffering from dangerous obstruction, the intestines being full of solid fæces and gas, and being much thinned from overdistention. The abdomen also was partially filled with serum and moderately distended. In stitching the gut to the skin I remarked on its unusual thinness, and took pains to put the sutures through the longitudinal bands for greater security. Trusting as I do a great deal to the single silver suture, it is not my practice to insert more than half a dozen silk stitches, to keep the bowel quietly in apposition with the cutaneous incision till union takes place, and that was done in this case. On the following day my assistant visited the patient in my place, and was told by the nurse that just before his arrival there had been a profuse gush of serum from the wound, soiling the dressings and soaking through into the bed. An examination revealed the fact that several feet of small bowel had also escaped through the wound by the side of the large gut, and were partially strangulated and growing cold. It was found impossible to reduce the protruded bowel without gaining room, wherefore the silver wire was cut and removed, after which reduction was accomplished without great difficulty. On my arrival it looked as though nothing had happened. The large bowel was in perfect position, and on one side was still firmly attached by the silk sutures. But on the other side two of these had torn out, and at this unprotected point the evisceration had occurred. A few sutures were put in through the entire thickness of the gut and the skin, and the gut was incised to prevent any further trouble. The man made an uninterruptedly good recovery, and was out of bed at the usual time.

I have never heard of another such accident as this. If it were of frequent occurrence, it could of course be guarded against by always opening the gut at the time of the operation, instead of a couple of days later as I prefer, and thus putting an end at once to all distention; but I shall not modify my practice till I see more occasion to do so than is furnished by this single case.

Another great advantage, besides location, which the inguinal opening offers, is the possibility of forming any sort of spur that may be desired.

The only object in forming an artificial anus, in all cases except those in which it is done to relieve obstruction, is to prevent the passage of fæces into a diseased rectum, and the operation is a success or failure just in proportion as this is accomplished. It is easy to make an opening in the groin and not accomplish it, and this is one reason for my saying that not every one can do the operation properly. It is not apparently so easy to accomplish this in the lumbar region as in the inguinal, for the simple reason that the descending colon is comparatively fixed, and cannot to the same extent as the sigmoid flexure be drawn

[1] The silver wire is passed in the following manner: One end of the wire is first prepared with perforated shot and shield, and the other threaded to a strong, sharp needle. The needle is passed entirely through the abdominal wall about an inch to the right of the incision, then under the gut through the mesentery, and then entirely through the abdominal wall again at the same distance to the left of the incision, from within outward. The wire is then drawn tight, so as to raise the gut well out of the incision, and the wire suture is made fast by another shot and shield. The suture should run under the gut at the junction of the middle and lower thirds of the portion exposed in the wound. (Kelsey, Diseases of the Rectum and Anus, 4th edition, page 419. New York, 1893.)

out of the incision and bent on itself to form a sharp and efficient spur. It has always seemed to me a very grave admission of Mr. Bryant's that in twenty-five per cent. of his cases he has failed to prevent the passage of fæces past the artificial opening. No such difficulty exists with the inguinal operation.

The lumbar operation consists in finding the colon, fastening it where it lies to the incision, and opening it. The inguinal operation does more than this, in that it brings the movable sigmoid flexure to the point desired, bends it over the wire suture at a sharp angle to form a spur, and fastens it there so as to prevent all subsequent passage of fæces beyond the opening. I have never known the operation to fail in accomplishing this, its main object, when skilfully performed. In reality there are two openings into the bowels, an upper and a lower, which have been likened by the younger Allingham to the openings in a double-barrelled gun, except that the upper or proximal one is much larger than the lower or distal. The distal opening is of great advantage in allowing the washing out of the rectum from above downward, to clear it from whatever fæces may have been in it at the time of the operation, and from any collection of pus which may accumulate from the ulceration.

An advantage claimed by Bryant for the lumbar incision is that patients can apply firmer compression to the wound to prevent prolapse of the mucous membrane. But prolapse has never been an annoying complication in any of my own inguinal operations. The patients generally have a truss made which fits firmly over the wound, exactly as in femoral hernia, but they seldom make much use of it, and are usually comfortable with a broad, firm, abdominal bandage.

A few words as to the after-condition of patients with an artificial anus may be of interest. The first thing accomplished is healing of non-malignant ulceration, and atrophy and contraction of the gut below the opening. This takes time. At first the discharge of pus and mucus from the anus will continue once or twice a day, and the rectum should be irrigated daily with some weak antiseptic solution from the artificial opening. After a time this will entirely cease. In cancerous disease, the relief to the tenesmus and frequent defecation is immediate, and the patients almost invariably begin at once to improve in appetite and general condition, and to take on flesh. After a few weeks there will generally be one, or at the most two solid evacuations from the colotomy opening daily, though if there has been much chronic obstruction before operation, with intestinal catarrh, it may take a considerable time to overcome the existing diarrhœa. When this has once been accomplished, however, as it can be by a few weeks of regulated diet, the patient's condition becomes a very comfortable one. Of actual control of the passage there is none in the proper sense of the word—power to prevent an evacuation which is imminent—but there generally has been none for a good while before the operation. The patient will often feel a warning of defecation for some time before the actual evacuation, as is natural in the rectum, and will have ample time to remove the dressing and prepare himself, but he cannot prevent it. His comfort depends upon the daily action of the bowels at a fixed time and his ability to escape diarrhœa. Exactly the same condition exists after most of the severe operations on the rectum and anus. There is

seldom good sphincteric action after extirpation for any cause, and yet the patients are comfortable. The choice between an anus without sphincteric power in the perineum and the same condition in the groin is, according to my contention, not sufficiently great to make it worth while to do a capital operation like excision, instead of one of little or no mortality like colotomy, to secure it.

A case reported a year or so ago in one of the English journals gives so good an idea of the whole subject that it may be instructive to refer to it. A poor woman in the hospital was an object of loathing to herself and everybody else because of incontinence of fæces from some old disease of the rectum. To relieve this uncleanly and disgusting condition an operation was done which to the popular mind produces just the condition for which she desired relief—left inguinal colotomy. The operation was eminently successful, and the patient was once more comfortable and happy.

For my own cases, I can only say that though I have done the operation many times upon men and women in every social scale, I have yet to meet the first patient who desired to have it undone, and to be placed again in the condition which existed before.

Excision or Extirpation of the Rectum.

Another great advance in the surgery of the rectum has been the application of the operation of excision to non-malignant cases. Formerly this operation was considered so dangerous as to be justifiable only in malignant disease, but with improved technique the mortality of the operation itself has been greatly reduced, and it now takes rank among our best means of treating non-malignant ulceration and stricture. Here again we have to consider carefully the indications for its performance, and first it must be noted that mere stenosis of the rectum, within easy reach of the anus and not associated with much ulceration, is comparatively amenable to local treatment by incision and dilatation combined. It would be a very extensive stricture indeed that would force me to do a colotomy were it unattended by ulceration, and the same statement applies in a measure to extirpation; but all rules for treatment must be modified by the surroundings of the patient. It seems hard to say that colotomy is often better for a poor man in hospital, and dilatation for a rich one in his own home, but it is unquestionably true. The treatment by division and subsequent dilatation must be kept up for years, and cannot be trusted to the patient, but must in great part be done by the surgeon. The hospital patient soon grows weary of attending the dispensary and of using the bougie, and in a few months the stricture is as tight as ever. Therefore, in the more severe cases, it is often better to do a colotomy at once, or, in those that are suitable, an excision. The strictures best fitted for extirpation are such as are less in extent than those for which colotomy is usually practised—cases where the ulceration cannot be cured by local treatment, and yet where the disease is not so extensive as to render its removal by the knife a capital surgical operation, and where the surrounding parts are healthy, so that primary union may be hoped for. Again, strictures which are situated far enough from the anus to allow resection and subsequent

suture with preservation of the sphincters, give much better results as regards the after-condition and usefulness of the parts than those which require amputation of the lower end of the gut and destruction of the anus. There is not enough choice between an anus in the perineum over which the patient has no control, and one in the left groin, to make it worth while for the patient to take any great risk for the sake of securing one rather than the other.

I am not then in favor of extirpation in old cases of extensive non-malignant disease, covering several inches of gut and attended by great thickening of the surrounding tissues, but prefer to confine the operation to those in which a good result, with control of the evacuations and without cicatricial stenosis or the formation of fæcal fistulæ over the sacrum, seems probable. I have operated in several such cases, in which the after-condition of the patient has certainly been better than it would have been made by colotomy.

There is, however, one class of cases—that of tubercular ulcerations—in which extirpation should always, if possible, be practised regardless of the subsequent utility of the parts, but merely to remove a focus of disease.

Resection of the Rectum.

Another of the great advances in this line of surgery in the past few years is the discovery by Kraske of a method of resecting instead of amputating the rectum. Formerly our only way of reaching new growths or old strictures was by an incision through the perineum, by which the anus was first freely divided to allow access to the rectal pouch. Kraske has worked out an incision over the sacrum by which it is possible to come down upon the rectum from behind, free it from its attachments, and resect many inches or even the whole of it, still leaving the sphincters untouched if desired. In this way the field of operation has been much enlarged, and many strictures previously considered too high up in the bowels to be safely operated upon, have become suitable for removal.

Kraske's operation [1] consists briefly in making a median cut from the second sacral vertebra to the anus; severing the left gluteus maximus from its sacral attachment; excising the coccyx; detaching the sacral connections of the tubero-sacral and spinoso-sacral ligaments; and chiselling away the lateral mass of the sacrum in a curved line beginning at the outer border of the third sacral foramen and terminating at the corner of the sacrum. When the disease involves the anus, this is next freed by a circular incision; the rectum is detached from its bed; the peritoneal cavity is opened also by a circular cut; the gut is drawn well down and amputated above the tumor, and its end is fixed by sutures to the para-anal tissues. Under other circumstances the bowel is divided above and below the seat of disease, and after the removal of the affected part the ends are brought together with sutures. This operation has been variously modified by Schede, Rinne, Levy, and Bardenheuer, who makes a transverse section of the sacrum.[2]

[1] Verhandlungen der Deutschen Gesellschaft für Chirurgie, Bd. ii., 1885; Kelsey, op. cit., pp. 397 *et seq.*

[2] Volkmann, Klinische Vorträge, No. 298.

A few years ago the danger of wounding the peritoneum in excision of a rectal growth was considered a contra-indication to the operation; but with Kraske's incision, or its modifications, the peritoneum is freely incised, the rectum in its upper part is freed from all its attachments, and after the removal of the diseased portion the upper end is stitched to the lower, or perhaps drawn backward and stitched to the skin of the incision to make a new anus in the sacral region. In the earlier cases the peritoneal opening was stuffed with iodoform gauze, but now the cut edges of the membrane are stitched to the serous surface of the bowels, in order to shut off the cavity from any possible contamination from the wound.

Comparison of Operative Methods.

Although by Kraske's method and its various modifications we can now remove more extensive disease than before, that is not its chief advantage. Its main value lies in the fact that it enables us to remove a class of growths not before removable on account of their distance from the anus, rather than on account of their magnitude and extent. To a conservative operator it seemed that too much was often done before Kraske made it possible to do more. But a growth which would have been deemed suitable for removal if within reach by a perineal incision, was left to its own course when it was four or five inches up the bowel on account of the gravity of the operation. Now, if the growth be a proper one for extirpation, it should be removed whether two inches or six from the anus, and this the dorsal incision and removal of part of the sacrum render possible without increased danger.

Unfortunately the surgeon sees few cancers of the rectum which invite removal. Generally they have involved too much tissue around the gut, and instead of extirpating a rectum the operation becomes one of extirpating the peri-rectal cellular tissue and lymphatics. This no incision and no manual possibility of performance has yet proved to be good surgery. It is true that we can do it. We may take out prostate, base of the bladder, rectum, and masses of cellular tissue, and the patient may survive; but it is yet to be proved that such surgery upon the whole tends to the prolongation of life.

It would be curious if we were to travel a second time over the same ground in this operation of excision of cancer of the rectum. After once being put before the profession it was almost abandoned, simply because the cases proper for its performance were not properly selected, and it came into bad repute. It was again revived, and has been carried further than before, and again the reaction has set in, since we see that because it is possible to remove much it may not be good surgery to do so.

Extirpation is now, as it was not years ago, always in competition with colotomy in prolonging life. In extirpation we strive for radical cure, which we get in a very small proportion of cases, and these generally easily known before the operation is undertaken. In colotomy we abandon the hope of radical cure and work simply for length of days and relief of pain, and in the great majority of cases we accomplish much more than by extirpation.

Of course some growths are palpably suitable for excision, and the surgeon would be derelict who neglected to remove them; these are the limited growths which can be completely excised without too great danger to life, such for example as epitheliomata near the margin of the anus. Here we have a class of cases showing excellent results as to recurrence, with little mortality from the operation itself. Again there are other cases where colotomy should as unquestionably be done, and not extirpation even though manually possible. These are the cases of extensive disease involving not only the rectum but the surrounding tissues and base of the bladder, and which have already led to lymphatic deposits. Between these is a class of cases about which the practice of surgeons will differ—the cases of deposit in the rectal pouch which, though involving two or three inches of the gut longitudinally in all its circumference, are still movable on subjacent tissues and can therefore be completely extirpated and without very great immediate risk. These are the cases that lead to so much disappointment. A brilliant and grave surgical operation is done, the growth is completely eradicated, and yet the patient is hardly convalescent before there is a recurrence in the cicatrix.

The sad truth is that cancer of the rectum is an exceedingly fatal disease, and but little amenable to treatment by the knife, tending as it always does to rapid recurrence. We shorten many lives by attempting its removal, and I have been unwillingly forced to the conclusion that, excepting in the class of mild cases referred to, we can do more good by colotomy than by excision, and can secure an average and aggregate greater length of days.

DISEASES OF THE BLADDER AND PROSTATE.

BY

HUNTER McGUIRE, M.D., LL.D.,

OF RICHMOND, VA.

CYSTITIS.

THE statement of Dr. Owen Rees, quoted in Mr. Harrison's article,[1] does not accord entirely with the results of modern scientific research as to the etiology of acute vesical inflammation. We cannot ignore the important relation which bacterial organisms of various kinds bear to acute and chronic inflammation of the vesical mucous surface. Mechanical irritation may be merely a predisposing cause, and soon becomes associated with germ infection, the traumatism furnishing a site for the action of pathogenic micro-organisms. It is probable that in some instances micro-organisms should properly come under the head of chemical irritants, inasmuch as it is their organic chemical products rather than the bacteria themselves which produce the inflammation. It is not unlikely that this is the true explanation of those fulminant types of cystitis that result from certain surgical procedures undertaken for the purpose of removing tumors, foreign bodies, calculi, etc., from the vesical cavity. There is, under such circumstances, what may be literally termed a culture bed of micro-organisms in the form of a chronic catarrh of the vesical mucosa. The urine, in such conditions, has been conclusively proved to be literally teeming with pathogenic microbes of various kinds. Traumatism opens up avenues for the absorption of these pathogenic microbes and their products, and consequently surgical operations upon the bladder are very frequently followed by the most disastrous consequences. An acute septic cystitis thus arising is occasionally the point of departure for so-called general urinary infection, forming one of the most fatal varieties of the type of general infection which is commonly termed "urethral fever."

The relation of gonorrhœa to cystitis requires some special attention. It is probable that the so-called gonorrhœal cystitis is not gonorrhœa itself, but the result of a mixed infection. Gonorrhœa is one of the most typical of mixed infections, and although it may be admitted for the sake of argument that the gonococcus is the specific and invariable primary cause of true gonorrhœal inflammation of the urethra, it by no means follows that the accidents and complications incidental to virulent urethritis are of necessity of gonococcal origin. The gonococcus,

[1] Vol. VI., pp. 229, 230, *supra*.

even in typical gonorrhœa, produced by inoculation with pure cultures, never exists independently of common pyogenic microbes.

Upon this subject,[1] Dr. G. Frank Lydston, of Chicago, says:—

"It is probable that in most of the joint, muscle, tendon, and other serious complications of gonorrhœa, other germs—or the products of other germs—than the gonococci, are responsible for the condition. The peri-urethral phlegmons and abscesses, the lymphangeitis, prostatic suppuration, acute cystitis, and acute inflammation of the kidney, and in women the peritonitis which occurs in the course of gonorrhœa, are due, not to infection with the gonococcus *per se*, but to other germs or germ products which are associated with it. I do not know of a more typically mixed infection than gonorrhœa." He further says: "Acute gonorrhœal cystitis is much rarer than is usually supposed, for the reason that what passes for that disease is usually a posterior urethritis. This latter complication of gonorrhœa may or may not be due to the gonococcus *per se*. It is probable that the constant contact of the urine is a very important factor in protecting the bladder from infection, as regards not only the gonococcus but the other pathogenic microbes which are associated with it. If the non-existence of a specific gonorrhœal cystitis be established, it will certainly greatly modify the existing views regarding this much dreaded complication of gonorrhœa. Even prior to the discovery of the gonococcus it was supposed that the gonorrhœal cystitis was due to specific infection—*i.e.*, to the specific poison of the gonorrhœal process. Since the discovery of the gonococcus it has been supposed in some quarters that the gonococcus was an exciting cause of a complicating cystitis."

Du Mesnil[2] denies that there is such a thing as specific gonorrhœal cystitis. He claims that when gonococci are found in the urine they are accidental ingrafts upon the infectious process, having entered the bladder along with the purulent products of the urethral inflammation. They are not, according to him, new products developed from true specific inflammation of the vesical mucosa. It is conceivable that in women urethral or vaginal pus may get into the bladder in this manner, but, as a matter of fact, gonorrhœal cystitis is relatively quite rare in women.

Du Mesnil claims to have determined by recent researches that gonococci produce no alteration in the composition of urine, cystitis with ammoniacal urine never being produced by these germs. He claims, moreover, that the urine either renders the gonococci harmless or kills them completely.

Recent researches with the cystoscope have been of some value in the study of the changes produced by acute inflammation. Finger, of Vienna, has made some very interesting cystoscopic studies of the pathological conditions of the bladder in so-called gonorrhœal cystitis. According to this authority the mucous membrane is pathologically altered to a degree commensurate to the extent and intensity of the inflammatory process. It is invariably most markedly altered toward the vesical neck. There is a distinct turgescence and reddening of the vesical mucosa, which is traversed by greatly dilated blood-vessels, and in very acute cases is dotted here and there with hemorrhagic areas in streaks or blotches. Sometimes the appearance is uniformly red. Lumpy collections of epithelium are to be seen here and there inter-

[1] Transactions of the Southern Surgical and Gynæcological Association, 1892.
[2] Virchow's Archiv, Bd. 126, 1891.

spersed with long, thready, streamer-like filaments which float about freely in the urine. These appearances vary but little in cases of acute cystitis of other origin.

The results of modern scientific research, especially in the field of bacteriology, have been of especial value in the study of genito-urinary disease. Most of the points which will be referred to regarding the pathogenesis of inflammation of the bladder, apply equally well to other portions of the genito-urinary tract. Pasteur had a very clear idea of the truth regarding urinary infection over twenty years ago. In 1875 he publicly expressed the opinion that urinary infection was due to pathogenic microbes accidentally introduced into the bladder. He said at that time, during the progress of the discussion in the Parisian Academy, "If I had the honor to be a surgeon I would never introduce an instrument into a patient's bladder without having observed the most rigid precaution to avoid the introduction of germs from the external atmosphere." Within the past few years the researches of such authorities as Bumm, Clado, Albarran, Hallé, Krögius, Rovsing, and Guyon, have shown conclusively the relation of microbial infection to infectious processes of the genito-urinary tract.

In 1886 Bumm reported eight cases of puerperal cystitis, in which he found a micrococcus common to all. Hallé,[1] in a good review of the subject, says that in his opinion the microbe discovered by Bumm was probably the Staphylococcus aureus. Clado,[2] in 1887, isolated from pathological urine a bacillus which he described as a septic form of vesical bacterium. He experimented upon animals with this bacillus, and produced cystitis by its introduction into the bladder. Injection of the same micro-organism into the peritoneum resulted in the death of the animal.

In 1887 Hallé reported a case which admirably illustrated the important bearing of microbial infection upon chronic inflammation of the bladder. This patient was affected by impermeable stricture, with an intense cystitis, and presented, following each attempt at forcible catheterization, violent febrile complications which finally resulted in death. The purulent urine collected and cultivated during life furnished in a condition of purity a culture for a non-liquefying bacterium. At the autopsy the same bacterium was found in a condition of purity in the pelvis of the kidney, in the parenchyma of the kidney, and in miliary abscesses in the renal structure. Albarran and Hallé,[3] in a series of joint studies of urinary infection, found this same bacterium in 47 out of 50 examinations of pathological urine. In 35 urines, studied by culture, 15 contained this bacterium in a condition of purity, while in 20 other cases it was associated with other micro-organisms. By injection of a pure culture into the bladder the authors produced acute cystitis in animals.

In 1890 Krögius[4] discovered a peculiar microbe in purulent ammoniacal urine, and he termed it the Urobacillus liquefaciens septicus. As illustrative of the many types of germs to be found in pathological

[1] Annales des Maladies des Organes Urinaires, Février, 1892.
[2] Bull. de la Soc. Anat., Octobre, 1887. Quoted by Lydston in Transactions of the Southern Surgical and Gynæcological Association.
[3] Bulletin de l'Acad. de Médecine, 21 Août, 1888.
[4] Soc. de Biologie, 23 Juillet, 1890.

urine, Rovsing's[1] observations are very interesting. This author found in 29 cases of cystitis 12 species of micróbes of various forms, some of which are quite familiar. He found, for example, the Bacillus tuberculosis, Staphylococcus albus, citreus, and aureus, and several new varieties to which he applied the names Streptococcus ureæ pyogenes, Coccobacillus ureæ, Diplococcus ureæ pyogenes, Micrococcus ureæ pyogenes flavus, and four other varieties which Hallé claims to be only the four preceding varieties robbed of their properties of pathogenesis.

A very interesting point with relation to the bacterial infection of the genito-urinary tract is the occurrence of descending infection of the kidney, ureter, and bladder. It has been demonstrated that germs may infect the glandular structure of the kidney, and that at a subsequent period either these germs, or their toxines, may cause inflam mation of the pelvis of the kidney, and, descending, may infect the bladder—that is, a cystitis may result from a primary nephritis of septic origin, the nephritis itself having been acquired by infection through the general circulation. It has been shown that germ infection has much to do with those interesting cases of fatal cystitis with gangrene of the vesical mucosa, which follow the sudden relief of prolonged retention of urine in cases of chronic vesical inflammation. The circulatory disturbance resulting from prolonged retention, followed by a sudden relief of pressure, has been experimentally shown to bear a very important relation to germ infection. Heubner produced temporary obstruction of the vesical arteries. The vessels were then released from compression, and it was found that a sudden influx of blood was followed by coagulation-necrosis and thickening of the bladder walls. The experimenter then injected pathogenic organisms into the blood simultaneously with the removal of the constriction of the circulation, and found that septic cystitis with gangrene of the vesical mucous membrane resulted. Guyon has found similar conditions to prevail by experiments upon the kidney.

Use of the Cystoscope in the Diagnosis and Treatment of Diseases of the Bladder.

One of the most important developments in genito-urinary surgery in recent years is the ocular examination and exploration of the bladder by means of the electric cystoscope. Although this instrument was really invented as early as 1879, it has only been within the last few years that it has approached a degree of perfection consistent with its practical employment by the surgeon. The perfection of the cystoscope has been due to the efforts of Dr. Max Nitze and Mr. Josef Leiter, and the perfected instrument of to-day presents a combination of the results of the inventive genius of these two gentlemen. Cystoscopy is approaching a degree of perfection in Europe of which even its most enthusiastic advocates never dreamed. It has not come into general use in this country, but a great many of our more prominent surgeons have become adept in the necessary manipulations. Dr. Willy Meyer, of New York, has done more work upon this subject than, perhaps, any other American surgeon. The improved pattern of cysto-

[1] Berlin, 1890.

scope is tunneled in such a manner as to permit, in favorable cases, of catheterization of the ureters. Brenner has successfully catheterized both ureters in the female, but has failed in the male. It is probable that as we become more familiar with the use of the cystoscope, and as the instrument itself becomes improved, cystoscopy will be reduced to as exact a science as is ophthalmoscopy. There are many cases on record at the present time that prove the extreme value of the cystoscope. Foreign bodies, encysted calculi, tuberculous infiltration and ulceration, and benign and malignant neoplasms have been demonstrated by this instrument as beautifully as could be imagined. In some varieties of vesical tumor the appearance presented by cystoscopic examination is so definite and characteristic as to be absolutely startling. In villous papillomata, for example, the delicate branchlets of the growth may be easily seen, floating about in the urine, and the superficial vessels of such growths, down to their minutest ramifications, may be observed with surprising distinctness. The cystoscopic appearance of chronic cystitis is of course dependent to a great extent upon the degree of the inflammatory process. In the slighter cases the mucous membrane has been described as of a white and rather gelatinous appearance. There is always in long-standing cases an increased thickness of the bladder, as demonstrated by the relatively greater prominence of its rugæ as compared with their normal condition. The network of vessels to be seen in the normal or acutely inflamed bladder is obscured by inflammatory exudate, and by the accumulation of small aggregations and streaming filaments of muco-pus, attached to the surface of the mucous membrane. In some instances more or less deposit of phosphatic salts is to be observed, this condition being verified by the sensation and sound imparted by touching the collection with the beak of the cystoscope. The *megaloscope* of Boisseaux de Rocher is claimed to have some advantages over the cystoscope. It brings into view a larger surface of the bladder at one time, but the objects seen are less distinct, and the instrument is more difficult to manipulate.

The future possibilities of cystoscopy are unquestionably great.

Hypertrophy of the Prostate.

In its normal state the prostate neither assists nor retards the flow of urine. Surrounding the first portion of the urethra, its two halves meeting both in front and behind this canal, its function is simply sexual. In man and other animals who have been castrated the prostate shrinks away, leaving a small, hard, fibrous mass which is but a trace of the original organ. Neither the atrophy following castration nor the normal increase of size and development that occurs during the breeding season in some animals influences the function of urination.[1]

When the normal size and shape have been changed, however, micturition may be seriously interfered with, but not necessarily.

Quite a number of cases of enlargement of the prostate have been reported in the last few years occurring in subjects under 55 years of age. Mudd reports one at 27 years of age; Packard one at 43; Bell-

[1] [Castration, as a remedial measure, has been practised by J. Wm. White and others.]

field one at 49 years, and a number of others where the overgrowth was attended by cystitis, retention, etc.

An examination of the prostates of a large number of men under fifty, suffering with some vesical disorder, has convinced me that enlargement of this organ frequently takes place at an earlier period than is usually supposed, but rarely gives rise to trouble until some pathological change in the bladder supervenes in consequence of senility. Guyon believes that the hypertrophy is due to general atheroma. Moullin says "that the primary change is the invasion of the surrounding tissues by a glandular growth, with more or less stroma, distantly resembling the normal structure of the prostate. Sometimes it spreads superficially, sometimes eccentrically. Its rate of increase may be rapid and irregular, leading to the formation of outlying bosses and nodules, or it may be slow and uniform, so that the gland enlarges equally in all its dimensions. The one gives rise to the soft adenomatous prostate, with possibly cysts and distinct encapsulated tumors scattered through it, the other to the dense and but slightly enlarged variety." This writer does not think that the enlargement is due to senile changes, and says that it is difficult to understand how general atheroma, always attended with defective nutrition, can explain the overgrowth.

In an address (1892) before the Detroit Medical Library Association on this subject, Prof. G. Frank Lydston, of Chicago, took the view that prostatic enlargement was due, in a majority of cases, to what he termed prostatic overstrain. This author believes that, inasmuch as the prostate is a sexual and not a urinary organ, it is in the direction of some perturbation of its physiological sexual function that we must look for an explanation of its pathological changes, with the exception, of course, of such pathological conditions as are incidental to traumatism or infection. Professor Lydston gives due credit to certain other factors in the etiology of prostatic overgrowth, such as gout, senility, etc., but claims that these factors are alike subordinate to prostatic overstrain, perpetuated for a long period during the height of sexual activity of the individual. This overstrain produces active hyperæmia and glandular proliferation, which if it persists for a long period is not followed by a restoration to the normal condition, but by permanent hypertrophy.

While prostatic enlargement may take place from an urethritis which has produced inflammation of the prostate, and more or less permanent hypertrophy may follow "prostatic overstrain," these conditions are not followed by loss of power of the muscular coat of the bladder and by an accumulation of residual urine, with all the consequent symptoms. Some other changes are necessary, and while these are occasionally seen in younger men, whose bladders may be said to be prematurely old, they are usually found in men after fifty-five years of age. These senile changes are very common.

Sir Henry Thompson[1] found in 200 post-mortem examinations of men over fifty-five years of age, that 1 in 3 had prostatic hypertrophy and that 1 in 20 had manifest symptoms of that condition.

Mr. Reginald Harrison,[2] since his article in the Encyclopædia was written, has given a very clear and satisfactory explanation of the

[1] Clinical Lectures on Diseases of the Urinary Organs, 8th ed., 1888.
[2] Surgical Diseases of the Urinary Organs, 3d edition.

causes of prostatic overgrowth. He insists that residual urine always precedes prostatic hypertrophy, and that the presence of this residual urine is due to some alteration in the shape of the bladder itself. In early life the bladder is almost an abdominal organ; as years go by it descends lower and lower into the pelvis, until in some instances the depression goes so far that the posterior wall is on a lower plane than the outlet of the organ. The bladder rises and falls in the pelvis, while the prostate is fixed by the triangular and pubo-prostatic ligaments.

As soon as the posterior wall or floor of the bladder, which by reason of its anatomical relations and absence of muscular tissue has little power of contraction, sinks below the level of the outlet of this viscus, incomplete evacuation of the bladder can only be prevented by repeated efforts of adjacent muscles. "This will eventually lead," says Mr. Harrison, "to the development of a strong muscular buttress between the orifices of the ureters, and also I believe to similar changes in the muscular tissue so largely entering into the prostate, and principally affecting its posterior segment." I have repeatedly seen this inter-ureteral bar in post-mortem examinations, and during suprapubic cystotomy for prostatic obstruction. The prostatic hypertrophy in many of these cases is, as Mr. Harrison says, compensatory. It is simply an increased development of muscular tissue to aid in the expulsion of urine. In about one case in twenty, according to the figures of Sir Henry Thompson just cited, tissue production is excessive, and the overgrowth of the prostate itself becomes an obstruction to the passage of urine.

The overgrowth of the prostate may be general, involving every portion of the organ, and along with this are very often found tumors, fibro-myomatous in character, like those found in the uterus. The increase may be due to hypertrophy of the muscular, fibrous, or glandular structure. The overgrowth may be confined to the so-called middle lobe, and may be sessile or pedunculated, or one or both lateral lobes may be enlarged. When one is involved, the urethra is deflected or twisted. When both lobes are overgrown the urethra may be reduced to a slit or chink, and very often large fibrous masses of prostatic tissue are pushed up into the bladder, giving rise to symptoms of stone or foreign body. Sometimes the projection into the bladder is, as McGill describes it, "a uniform circular enlargement surrounding the internal orifice of the urethra, like a collar." If the hypertrophy does not interfere with the lumen of the urethra, no trouble arises. If obstruction to the function of micturition exists, then symptoms arise, which may become alarming and threaten life.

During the last few years a number of operations have been suggested for the relief of the symptoms following prostatic hypertrophy. No drug has been found to relieve the enlargement. Interstitial injections of iodine, ergot, sclerotic acid, and other agents have been used, but without success or even benefit. Electricity has also been employed in different ways, and some good results are claimed for it. Its application is painful, and at best, in the present state of our knowledge, its effects are uncertain. Newman uses the electro-cautery, which he applies to the mucous lining of the prostate. He says that he has accomplished much good by it, but that many applications are required.

Casper, Biedert, and Roux have used the galvanic current to reduce enlarged prostate, very much after the manner of Apostoli's use of this agent in fibro-myomata of the uterus. The negative pole is introduced into the rectum, and a fine needle attached to this pole is pushed through the mucous membrane into the prostate. The positive pole is placed on the lower part of the abdomen. Casper employed a current of twenty-five milliampères, and Roux one of seventy milliampères. Biedert says that in one case out of five reduction in the size of the gland followed. In some cases both Casper and Roux say that the organ diminished and that improvement ensued; one case was followed by rectal fistula. Professor Bottini, in March, 1891, claimed that in 75 cases he had had only 2 deaths, 32 cases improved, and 12 treated without benefit by internal galvano-cautery.[1] W. Bruce Clarke records 4 cases in which he tried Bottini's method, with complete success in 3, and marked improvement in the fourth case. He says that this procedure is applicable in cases where the obstructing portion is very small. Mercier introduces through the penis an instrument having a male and female blade, something like a lithotrite, and punches out a portion of the prostatic tissue about the neck of the bladder. Gouley's operation is a modification of Mercier's.

Prostatectomy has been done through the perineum, by first performing median lithotomy, then finding the projecting or obstructing portion, and removing it with the finger or with special forceps or curette. Bellfield says that in many cases the obstructive part, middle or lateral lobe, has been removed in this way. Watson, of Boston, has shown, however, that while in two-thirds of the cases requiring operation the growth can be reached by any one "possessing a finger that has a working length of three inches or more," in one-third of the cases the vesical growth cannot be reached and removed by the perineal route.

The depth of the perineum varies much in different individuals; it is often rigid and loaded with fat. Another serious objection to the perineal incision is the small space the operator has for manipulation.

Dittel's operation of lateral prostatectomy has met with some success. A catheter is tied in the urethra, and the rectum is filled with gauze, so that both of these structures may be more easily recognized and avoided. The patient lies on his belly with his legs hanging down. An incision is begun at the point of the coccyx, and carried to the right, around the sphincter ani, to the median line in front; the ischio-rectal fossa is thus opened, the rectum is pushed aside, and one lateral lobe of the prostate is exposed; further dissection to the left of the middle line is then made and the other lateral lobe is brought into view, when a large wedge-shaped piece is removed from each. When the obstruction is due to enlargement of the lateral lobes and the prostatic urethra is compressed to a slit, this operation may be attended with benefit.

By far the most successful and practical operation, however, is that devised by McGill, of Leeds. A suprapubic cystotomy is done in the ordinary way and the obstructing part of the prostate is removed. The mucous membrane covering the projecting portion is cut through, and the operation is completed with the fingers and the forceps; the écraseur and the rongeur forceps may also be useful. The prostatic tissue

[1] British Medical Journal, December, 1892.

removed varies in size from that of a "bean" to that of a "cricket ball," and in weight from a few grains to two or three ounces.

Dr. Bellfield proposes that when the suprapubic operation fails to relieve the obstruction, and the urethral canal is not entirely patent, it should be supplemented by a median perineal urethrotomy. That is, he does a combined suprapubic and perineal operation. The mortality following the perineal operation is, according to Bellfield, nine per cent., and that of the suprapubic sixteen per cent. Moullin says of McGill's operations, that of the 94 cases of which he has been able to collect satisfactory notes, 19 have ended fatally, upward of twenty per cent.

Fortunately two-thirds of all patients with prostatic enlargement go through life without requiring treatment. Many of them are unconscious of having hypertrophy; some of them suffer only from an increased frequency of passing water. Some of them require the occasional use of the catheter, and a large class habitually use this instrument to empty the bladder, and live for many years in this way in comfort. It is only when the overgrowth interferes with micturition, acting obstructively, that trouble begins. In a certain proportion of cases there comes a time when careful dieting, general hygiene, etc., with the constant use of the catheter, fail to give relief. The catheter is more and more difficult to introduce, and when withdrawn is followed by straining and tenesmus, and gives no relief to the sufferer. Cystitis comes on, the urine is ammoniacal, sleep is broken and disturbed, appetite fails, and breaking down of the general health soon follows. Medicine, general and local, fails to do any good, and it is by surgery alone that one can hope to prolong life. The electrical operations referred to, and the penile operations of Mercier and Gouley, need not be considered—the results obtained from them may temporarily be satisfactory, but speedy relapse takes place.

I do not believe that any surgeon who has tried both perineal and suprapubic prostatectomy will hesitate to select the latter operation in the future. The suprapubic opening gives more room for manipulation. The operation is very simple, the incision going through structures where there is no blood-vessel or nerve large or important enough to have a name. The interior of the bladder is in view, and hemorrhage from that organ is easily managed; if hot water fails to control the bleeding, the bladder may be packed with iodoform gauze, as I have repeatedly done. In sixty-five suprapubic cystotomies for different purposes that I have performed, I have never seen the peritoneum, nor have had urinary infiltration. Drainage by this route is effected better than by the perineal opening. In the latter operation the posterior wall of the bladder is below the level of the wound, and some special arrangement of drainage-tubes, as proposed by Harrison and Watson, must be used to keep the bladder empty.

The foregoing are the most important of the various methods suggested for the relief of symptoms attending prostatic obstruction. If, however, the position taken by Mr. Harrison in regard to the etiology of prostatic overgrowth is correct, then all of these prostatectomies are illogical and valueless. Mr. Harrison says, and his observations are confirmed by others, that the first change is the sinking down of the posterior vesical wall, the presence of residual urine, the necessity for

increased muscular strain to empty the bladder, the formation of an inter-ureteral muscular buttress, and then compensative prostatic enlargement.

Guyon, of Paris, says—and the whole French school agree with him—that the overgrowth is not the result of a local process, but is due to a general atheroma, and that similar alterations are going on at the same time in all the other portions of the urinary organs.

Sir Henry Thompson[1] says, "I think I am entitled to require that if it does happen, or has happened, to any surgeon to divide or remove any part of an enlarged prostate for a patient who has been compelled to pass all his urine by catheter, say for a period of twelve months, and that after the division in question he has been enabled to dispense with the instrument, or at any rate to pass, say, only half his urine by natural effort, the case ought to be seen and examined by others. I desire extremely to see such a result from any of the proceedings alluded to. I have long wished to see this sight, and have travelled considerable distances abroad and elsewhere expressly seeking it, but at present without success. Such is my report concerning this matter, and I am bound further to add that the restoration of the function by such means can scarcely be expected to occur." Harrison, Guyon, and Thompson are high authorities, probably the highest we have.

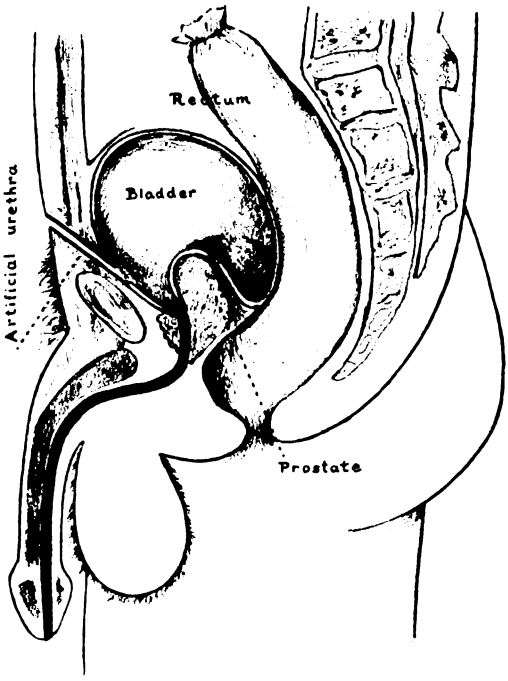
But apart from the statements of these gentlemen, when we consider the fearful risk of death after McGill's operation—generally regarded as the best of all the prostatectomies suggested—from sixteen to twenty per cent., and this in the hands of the best operators; when we remember that it is not always possible to remove the obstructing portion in this way, or that the obstruction, though removed, may recur, and that if there is atony of the bladder that organ may never regain its power; when we consider, too, that the patient is usually old, feeble, and broken down in health by long suffering, with nephritic disease threatening or in existence—we naturally ask if there are not some less hazardous ways of getting relief for these cases? Fortunately there are. One of them was suggested in 1884 by Mr. Harrison, and is well described in an appendix to his article. I have operated in this way several times, and with much good to the patient. In 1887, however, I tried drainage by the suprapubic route, and with better and more satisfactory results than I obtained through the perineum.[2] The operation is at first a simple suprapubic cystotomy, as described in all works on surgery. The rectum should be distended by a rectal bag, as by this means the bladder is pressed upward and forward, and somewhat fixed againt the anterior abdominal wall. This is much better than simply adopting the Trendelenburg position, in which the bladder will fall away from the anterior abdominal wall. No force should be used in distending either the rectum or the bladder. Several instances of rupture of the rectum, and a still greater number of rupture of the bladder, have been reported from overdistention. In the absence of the rectal bag, the rectum may be distended with sponges or cotton. It is much more important to distend the rectum than the bladder.

[1] Diseases of the Urinary Organs, 8th ed., p. 134.

[2] My first paper on this subject, The Formation of an Artificial Urethra in Prostatic Obstruction, was read before the American Surgical Association in September, 1888, and appears in the Transactions for that year.

Five or six ounces of water in the latter is sufficient, but one or two ounces will do. I have never seen the bladder so contracted, as reported by McGill and others, that it could not be reached by this route. After the bleeding, which, unless the prostate has been nicked, is trifling, has been arrested, the bladder should be examined, first by the finger and then with a small electric light (pea size) introduced through the suprapubic wound, or an assistant with two fingers in the rectum may push the posterior wall of the bladder up into the wound, when it can easily be inspected. A large catheter is now introduced through the wound into the bladder, and the water in the rectal bag is permitted to escape; as it does so the bladder sinks lower and lower in the pelvis, until the vesical opening is two and a half or three inches lower than the centre of the abdominal incision. It is important to make the catheter follow the bladder as it descends, or it will escape from the organ altogether. To avoid the necessity of introducing into the bladder any greater length of tubing than necessary, the opening in the catheter should be at its extreme end, and I have lately had catheters made without any lateral opening at all. No stitches are used. Before beginning the operation it is important to have the urine acid. Normally acid urine is aseptic, very acid urine is antiseptic. The free use of citric acid in the shape of lemonade is the best way that I have ever seen of making the urine acid. After the operation the wound is permitted to heal until no opening is left in the bladder except the track occupied by the catheter. This track should be two and a half or three inches long, should run upward and forward from the bladder, and should occupy the same relation to that viscus that the spout does to a coffee pot (see Fig. 1740). Generally the man can hold his water and expel it at will. Unless the water in his bladder rises above the level of the external opening of the artificial urethra, or even higher, because the recti muscles act slightly as a sphincter, there is no leakage no matter what position his body is in. I have repeatedly seen a man throw a stream of urine, through the new urethra, a yard from his body, the last of it coming in jets as from the natural channel. Some of my patients are able to retain the water two or three hours during the day, and five or six hours at night while lying down.

Fig. 1740.

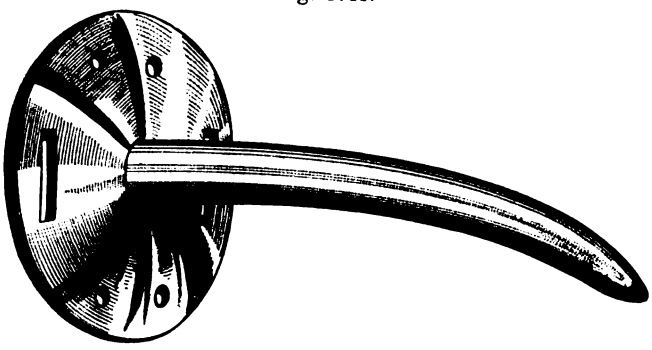


Operation for Making an Artificial Urethra.

To keep this track open, however, it is necessary to wear a silver or

aluminum plug (see Fig. 1741). This is from two and a half to three and a half inches long, and is retained by straps around the hips. It is, of course, to be removed when the patient desires to pass water, and immediately after urination it is replaced. It is important that this plug should not project farther into the bladder than just through the vesical wall.

Fig. 1741.



Obturator for Use After Formation of Artificial Urethra.

But suppose the case to be one of atony of the bladder, and that it is impossible for the man to urinate in this manner—for prolonged retention, with overdistention, and repeated attacks of, or persistent, cystitis, will lead to degenerative change and to loss of muscular power more or less complete. When the loss is complete, power is rarely if ever regained. The continued use of the catheter does not in my experience lead to atony, as Sir Henry Thompson and others teach. I have seen the power of the bladder preserved after six years of catheter life. During the flow of urine through the catheter the bladder is not an idle, inactive bag. Even then voluntary and involuntary muscular contraction is going on, and muscular power is preserved unless some of the causes above mentioned intervene and destroy it. If there is vesical atony, however, none of the prostatectomies described will enable the patient to voluntarily empty his bladder. Complete enucleation of the prostate would not accomplish this. The only thing left now is drainage. This can be better performed by the suprapubic artificial urethra than by a perineal fistula. In the latter the patient is annoyed by constant leakage of urine. By the suprapubic track the catheter may be made to act as a siphon, and vesical irrigation may be freely used. The man can take care of himself without the aid of an assistant. If no longer needed the suprapubic opening is more readily closed than one in the perineum. Through the suprapubic track I have carried a lithotrite, and have caught, crushed, and removed a stone which was lodged in a vesical pouch, and which could not have been reached through the natural urethra.

If after the bladder is opened a pedunculated hypertrophy of the third lobe is found, or if fibrous masses of prostatic tissue project into the bladder, it is proper to attempt their removal if the condition of the patient will justify it. These masses lying in the bladder act as irritants, and are almost as injurious as stones or other foreign bodies.

Professor Poncet, of Lyons, France, reports 35 cases of suprapubic cystotomy for the formation of an artificial urethra, with no deaths. I have operated on 39 cases with only two deaths, both from pre-existing but undetected pyelo-nephritis.

URINARY CALCULUS.

BY

E. L. KEYES, A.M., M.D.,

OF NEW YORK.

In reading over the article which it is the purpose of this supplementary paper to endeavor to bring up to date, I have been rather struck with surprise at the very moderate amount of new information concerning the subject under discussion which it has been my fortune to observe, or which has entered my experience in any way, either practically or through reading during the period which has elapsed since the appearance of the first essay. Indeed, although some startling advances, scientifically and practically, in other operations upon the urinary tract have crystallized into shape of late years, it seems that very little real advance has been made in any direction touching the subject of urinary calculus and its management. As far as I am aware, there have been very few new suggestions made from reputable quarters touching upon such serious points as the cause of stone, the classification, the structure, or the rate of growth. The recent work of Ebstein and Nicolaïer[1] is the only communication of moment and recent date bearing upon the scientific aspect of stone formation.

This treatise is a natural sequence of Ebstein's former work. He and Nicolaïer in 1886, at the Medical Congress in Wiesbaden, made known the results of their first experiments with oxamide; and the present treatise sets forth their findings after more extensive study.

They attempted to produce acid stones by feeding dogs with uric acid, but failed totally, although they caused one dog to take 1290 grammes in five and a half months.

With oxamide, however, alone or combined with oxalic acid, their results were positive upon a variety of animals. The calculi of oxamide were found always multiple, and generally in both kidneys—in the calices, never in the kidney substance—and in the ureters and bladder. The nuclei of the calculi were organic, and there was always more or less infiltration of the epithelia with crystals of oxalate of lime.

The conclusion is that the oxamide acts upon the epithelium as a poison, causing partial necrosis with detachment, and that the detached scales form the nuclei for calculous deposit.

Basing their deductions on these experiments, and applying them to

[1] Ueber die experimentelle Erzeugung von Harnsteinen. Wiesbaden, 1891.

man, the authors conclude that calculi develop under the following conditions:

I. A process of necrosis, which, as in the oxamide experiments, furnishes the organic substance of the calculus without inflammation.

II. An inflammatory process which does the same thing.

III. A combination of the two causes.

As would naturally have been expected, novelties and peculiarities in the gross characters of calculi have been recorded, but nothing needing citation here; nor, as far as I am aware, have there appeared any better methods of analysis than those which I brought together in the first article. Indeed, it appears to me that the less said here the better about the varying qualities and behavior of stones, and the different portions of the urinary tract which they occupy, or about the spontaneous fracture of calculi, since any remarks which might be made would necessarily be more or less repetitions of the ideas advanced in my previous essay. One little exception may be alluded to for its novelty, touching the possible nuclei of stone; it is found in the case reported by Kendal Franks, of Dublin, which I have elsewhere referred to,[1] of a man, twenty-two years old, who had in his kidney a stone the nucleus of which was a sewing needle, which had reached this peculiar locality in its act of travelling through the tissues in the endeavor which such sharp objects make to escape from the body.

Symptoms and Diagnosis.

Touching the subject of the symptoms of urinary calculus, too much stress cannot be laid upon the necessity for searching every case in which even obscure indications point remotely to the possibility of a stone. I may instance three personal cases which have emphasized this fact particularly to me. One was that of a boy, who had for symptoms only a little itching at the glans penis with a persistent tendency to masturbate, and who passed through my hands and those of several surgeons unsearched, because the suspicion of calculus did not arise. He went to one of our largest city hospitals and stayed there through the service of two surgeons, one of whom removed the prepuce without effect. For some reason it occurred to the last surgeon to search the bladder, and a stone as large as a pullet's egg was found in it, and removed.

Another case was that of a cigar manufacturer, who, after visiting a number of surgeons, applied to me for vesical irritability. He had no symptoms whatsoever excepting this one, and the urine was almost absolutely pure and sparkling. It did not occur to me to search for a stone, and I confined my surgical attentions to the prostatic urethra, and when finally I learned that this patient had visited another surgeon, who had sought for and easily detected a stone in his bladder, my chagrin may better be imagined than described.

The third case was that of a patient forty-four years old, who had been born with bladder symptoms of some indefinite sort, and had always suffered therefrom. This man had been searched in most of the cities of the West, and once by a surgeon whose name is perhaps better known

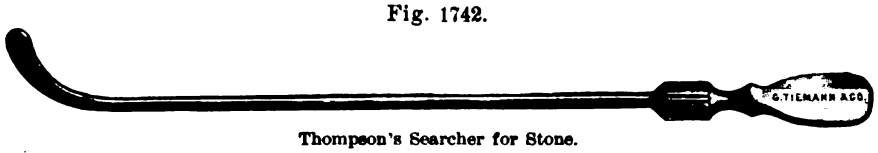
[1] Sajous's Annual, 1890. E. 33.

in this country and in Europe, for brilliant surgery, than tha. of any other gentleman west of Philadelphia. Three of these searches had been made under chloroform or ether; one had been so severe that the urethra had been lacerated and urinary infiltration had followed, with sloughing, and when the patient came to me the floor of the urethra at the peno-scrotal angle was gone for the distance of nearly an inch, yet no one, among all these surgeons, had been able to detect a stone. I placed this patient upon the lounge, introduced the steel searcher, and detected a stone in a period not exceeding five seconds; and this stone I afterward removed by suprapubic section, and have it now in my cabinet. It is as large as a goose's egg and the patient is a well man. Therefore it cannot be too urgently insisted upon that in every case of obscure vesical disease, search for stone should be made.

Outside of the means commonly accepted, and notably the lithola-paxy washing bottle and small tube, which is still a very efficient means of finding small stones and fragments, two improved methods of detecting stone should be alluded to here: one of them an improved searcher, and the other the cystoscope.

The newest searcher offered to the public is that of Sir Henry Thompson, which is represented in the accompanying figure. The

Fig. 1742.



Thompson's Searcher for Stone.

points of advantage which it possesses over the old searcher—points which I think are verified in its use—are the following: It is solid, and therefore aseptic; the tube instead of being bulbous is flattened laterally, which gives a larger metallic surface to impinge upon the foreign body for a given calibre of shaft; the corrugated cylinder in the handle is rough and nicely balanced upon the instrument, so that the movements of rotation can be made to sweep the tip of the instrument evenly over the whole field of operation at any given rate of speed; finally, the flat handle is roughly corrugated upon one side so that it may be firmly grasped, and this allows the surgeon suddenly to lap the instrument over a large arc of a circle, in making a sudden blow for the purpose of eliciting a click when a supposed foreign body has been found.

The cystoscope needs no description here; its value can hardly be overestimated in expert hands in any doubtful case.

Upon this point—namely, a doubtful case—it is fair to assert that it is hardly possible for a surgeon of any reasonable amount of experience at this day and date to mistake anything else in the bladder for a stone; and that for a patient to be cut for stone and none be found, in the present state of our knowledge, would be a very disgraceful circumstance, although this error is known to have occurred in the hands of the masters of surgery in former days. The only thing that could possibly be mistaken for a stone is an incrustation of urinary crystals upon an ulcerated surface of some sort within the bladder, and any one who has felt such a roughened surface once will undoubtedly recognize

it a second time. That the sensation given to the searcher by contact with the fibrous walls of the bladder, the brim of the pelvis, a hard ridge on the surface of the bladder, or anything else, should be mistaken for stone, is hardly to be considered possible now when the cystoscope and the washing-bottle and tube give us the means of verifying or disproving a doubtful diagnosis.

I may mention here for novelty a personal case, namely, that of a young gentleman with encysted prostatic stone, who, after being searched in vain at other hands, had his diagnosis perfected by me with the deep urethral syringe, the point of which, being inserted into the prostatic sinus, was brought into contact with the encysted stone through the instrumentality of pressure upon the prostate through the rectum.

Encysted stone within the bladder may of course escape detection by any means excepting the cystoscope and surgical exploration through a cutting operation.

Preventive Treatment.

Efforts in the direction of discovering a reliable preventive treatment of stone have done little more than accentuate the value of roads already travelled in this direction. The new substance, piperazin, has in my hands proved devoid of value in correcting the uric acid diathesis, and it is doubtful whether we possess any better means of breaking up a stone-forming habit than by correcting digestive errors and improving by exercise and oxygen the performance of the various vital functions. The free use of alkaline diluents is not always wise, but the constant simple free dilution of the fluids of the body by such waters as the Bethesda, Poland, Wildungen, and the like, holds as high a place as ever in the preventive treatment of stone. Even less advance, if possible, has been made in the solvent treatment of stone. As far as I know, positively no new claims in this direction have been put forward.

Selection of a Mode of Cure.

Formerly the conclusion reached by most reputable authorities was, that children should be cut laterally and that adults should be treated by litholapaxy, unless the urethra was strictured or other complications made cutting necessary, and that old men should be submitted to litholapaxy if it were in any way possible mechanically to accomplish the operation. In any of these instances, if the stone were very large, if there were vesical tumor, encysted stone, or certain foreign bodies, or if the stone were too hard to be broken by the lithotrite, suprapubic lithotomy was considered the proper method of treatment. This last conclusion has not been shaken by time, and still holds for all ages, and the same may be said of the second conclusion, that referring to adults. But in the minds of many the first and third conclusions have undergone serious modification, in this, that at the present day the child, even the baby, formerly considered the most appropriate for the knife, now turns out to be the best adapted for the crushing operation, yielding statistics to the lithotrite which are not surpassed or equalled

at any age; and that the old man now, whose stone is generally rather a symptom of prostatic obstruction than itself a true malady or source of disease, is often considered a more fit subject for suprapubic section than in former days, not because this operation is at all necessary to relieve him of his stone, but because his necessity is turned into the surgeon's opportunity, so that the prostate, the true cause of his sufferings, may be attacked by prostatectomy during the effort at removal of the stone.

RELAPSE.

Relapse after the crushing operation is less to be feared now than formerly; that is, such relapse as is due to leaving behind small fragments of stone in the bladder, because, by the aid of the cystoscope, we may now decline to discharge the patient as cured until one or more thorough searches after the presumptive last fragment have verified its actual absence.

Before taking up the direct question of the management of the patient or his calculus, it may be well to interpolate here the rather radical utterances of Surgeon-Major Forbes Keith, of Hyderabad, Sindh.[1] This gentleman formally proposes complete abandonment of the operation for removing calculi entire from the bladder. He remarks: "In the course of the three years I have held this appointment" (that of civil surgeon and superintendent of the medical school), "I have operated seven hundred and thirty-nine times for stone. In the month of May last, I performed fifty operations for stone; thirty-seven lithotrities and thirteen by other methods to be subsequently described, all successfully notwithstanding that the thermometer stood at 104° in the operating theatre, and that the cases operated upon were indiscriminately undertaken as to age, sex, duration of disease, condition of health, or size of stone." With such a statement what more can be said about statistics or about other methods than crushing, excepting that perhaps in India the patients are so tough that operations do not kill them. Dr. J. G. Wishard, connected with the missionary station in Teheran, Persia, recently informed me, while on a visit to this city, that there had been a certain surgeon in his district who had a very successful record as an operator in cases of stone in the bladder. This gentleman it appears died, and his wife, absolutely unacquainted with any medical or surgical subject, as far as known, finding herself deprived of support on the death of her husband, got together his instruments and commenced to operate for stone, and my informant vouches for the fact that up to the time of his departure she had operated about one hundred times with a success which was respectably good. Again Mr. Keith says:[2] "Since receiving my new instruments from home in February last, a period of ten months, I have had a series of one hundred operations without a death, and one hundred and fifty-seven with three deaths." This is surely a very admirable record, and would seem to justify Mr. Keith in his endeavor to establish the supremacy of the crushing operation to the exclusion of all others. For a very large stone he proposes to slit the perineum and operate in a manner some-

[1] Indian Medical Record, December 1, 1891. [2] Loc. cit.

what similar to that formerly proposed by Dolbeau. For these large stones he claims seventy-six operations with two deaths. For very hard stones he uses a chisel and hammer through the perineal opening; in this way he removed successfully from one patient seventeen ounces of débris, and thus he justifies his opposition to the removal of any unbroken calculus from the bladder.

Selection of a Method of Radical Treatment.

Perhaps under this head more may be said than under any other to show the drift of professional opinion since the original article was written to which this is a supplement. Practically all the crushing work upon young children has been recorded since then. A larger part of this has been done in India, and to P. Freyer, whose records have been given to the profession through the British Medical Journal,[1] the profession is greatly indebted, as it is to D. F. Keegan, of Indore, whose cases appeared in the Indian Medical Gazette,[2] and subsequently in the Lancet.[3]

Freyer, in his second communication, gives a record of a hundred consecutive successful cases, and Keegan, who it appears received the idea from T. Beaumont, of Indore, tabulates 114 litholapaxies in young boys by himself and Caldecott, and by an Indian surgeon, with only 4 deaths, some of the children being very young and small, and several of the stones exceedingly large. Keegan's last report, up to 1890, includes 125 cases with 4 deaths, all from extensive pre-existing kidney disease: the children ranging from one and three-fourths to fourteen years, and the stones from two up to six hundred and six grains.

As early as 1887 and 1888, crushing operations upon children had been performed in England by Walsham, Willett, Uthol, Cadge, and Morgan. In this country the first successful cases of the crushing operation upon children are the four reported by D. P. Allen,[4] the only serious criticism upon them being that the children should rather have been classed as young men, being, respectively, thirteen, thirteen and a half, fifteen, and nineteen years old. J. Wm. White, of Philadelpia, has also recorded a case for this country, and E. Hurry Fenwick in England gathered together, in 1888,[5] 106 cases from all sources, of children operated upon by litholapaxy between the ages of two and fifteen years, with a mortality of $\frac{9}{10}$ of one per cent.

Surely no better statistical showing than this could be demanded for any operation, and the future of litholapaxy for young male children seems assured. Personally I have not operated upon any young male child by this method, having seen no case of stone in a male child for many years. In female children I have applied it successfully.

Comparing the results claimed to have been attained by different methods up to recent date, no better exponents of German and English surgery need to be cited than Dittel, of Vienna, and Sir Henry Thompson, of London. The question now considered, of course, is the com-

[1] December 24, 1888, and October 12, 1889.
[2] October, 1888.
[3] October 4, 1890.
[4] Medical News, September, 1887.
[5] Provincial Medical Journal, Feb. 1, 1888.

parative statistics of operations by different methods in the hands of a single, not a number of operators. Dittel's figures[1] are to the point:—

	Number.	Cured.	Improved.	Died.	Mortality.
Lithotrity	178	148	7	23	12.92 per cent.
Litholapaxy	192	179	1	12	6.25 "
Lateral Cystotomy	65	39	1	25	38.46 "
Median "	40	20	1	19	47.50 "
Suprapubic "	26	13	1	12	46.54 "

Sir Henry Thompson, in reporting his statistics of 964 cases of operation for stone,[2] concludes, after comparing litholapaxy with the old operation, that the former procedure has reduced his mortality in crushing to nearly one-half.

This testimony is hardly needed at the present day to accentuate the value of litholapaxy as compared with the old-fashioned crushing operation, yet it is refreshing to give it, if only in the way of repeating a known fact. Besides the cases already alluded to, as reported by Surgeon-Major Freyer, 165 more cases appeared at a later date over his name with 3 deaths; these I have referred to in my digest on the subject in the annual already referred to.[3]

To speak for France is to refer to Professor Félix Guyon, whose strong advocacy of litholapaxy is a matter of historical record. This gentleman advocates many sittings, rather than one, in the case of atony of the bladder with phosphatic stone, since, as he avers, the washing-bottle does not seem to attract the fragments in these atonied bladders at a distance greater than an inch from its eye, wherefore he thinks a number of sittings may do the work more effectually than one very prolonged operation. He advises the use of a 1–500 solution of nitrate of silver, before and after each sitting, for its antiseptic value. No better statistics exist than those of our own countryman, George Chismore, of San Francisco, who in November, 1892, had had sixty-three consecutive litholapaxies without a death. Most of these were published in the Journal of Cutaneous and Genito-Urinary Diseases for August, 1890, and October, 1892.

This question of statistics as bearing upon the present status of the results, and therefore influencing the choice of operation in a given case, is so important that it will bear considerable amplification and elaboration.

I have been favored by Dr. A. T. Cabot, of Boston, with some modern statistics which he has collected from various sources for an article of his own upon urinary calculus. These statistics were gathered together to show the present mortality status of the various operations, and are interesting as indicating the present improvement in lithotomy—an improvement due doubtless in a measure to modern antiseptic methods and to better modern means of controlling hemorrhage.

In my former article I tried to present the general mortality status of perineal lithotomy when estimated according to that most important factor, the patient's age, and I did this by presenting the table according to decades as given by Coulson from a collection of 2972 cases, and by Thompson from an analysis of 1827 cases. Now I add Cabot's collection of 674 modern cases since 1878, gathered from various sources,

[1] Wien. med. Wochenschrift, 4 Feb. und 17 März, 1888.
[2] Lancet, March 15, 1890.
[3] Sajous's Annual, 1892, E. 13.

published and unpublished. And to this I may add Freyer's table of 987 Indian cases, which Cabot also has. A tabular presentation of these statistics is interesting as showing the results of operations before and after 1878. The tabular comparison, however, cannot be quite accurate, as some of the tables are in decades and others in broken groups as to age; but I have tried to generalize them sufficiently for comparison as occurring before and after the date 1878, the time since which modern antiseptic methods may be said to have prevailed.

Age.	Coulson's Collection, 2972 Cases. Lateral.	Thompson's Collection, 1827 Cases. Lateral.	Cabot's Collection, 614 Cases. Lateral.	Freyer's Collection, 987 Cases. Lateral.	Cabot's Collection, Suprapubic Lithotomy. 744 Cases.	Cabot's Collection, Litholapaxy. 1074 Cases.
1–20 Coulson, Thompson, and Freyer, 1–14 Cabot,	Mortality before 1878. 4.25%	Mortality before 1878. 3.75%	Mortality after 1878. 2.96%	Mortality in India in 1883. 5.10%	Mortality. Modern cases. 12.52%	Mortality. 1.66%
20–50 Coulson and Thompson, 14–50 Cabot, 20–40 Freyer,	19%	15.25%	11.30%	10.70%	12%	3.25%
50–80 Coulson and Thompson, Old men, Cabot[1] (only 48 cases); above 40, Freyer.	30%	22.50%	16.66%	31.90%	32.07%	6.00%

I need not go over again the line of statistics covered by my former article. These new ones, and particularly their tabular comparison, must show, if anything ever is shown by general statistics, three things most prominently:

I. That modern lateral lithotomy statistics are better than ancient ones, due doubtless to (*a*) selection of cases, (*b*) antiseptic methods (internal and external), and (*c*) better operative technique as regards hemorrhage and irrigation.

II. That the suprapubic method is totally unfit for children (a reserve being made for very large stones), the mortality being more than four times as high as for the lateral operation—the mortality, indeed, ranking quite as high as for middle life when the suprapubic operation is resorted to—while in old age the statistics of this operation have not improved over its old showing given in my first article, as being, at an all around average, about thirty per cent. Cabot makes it 32.07 per cent. Although the number of his collected cases is small, out of his total collection at all ages (744 cases) the mortality is about nineteen per cent. A man therefore who manages to save more than three cases out of four by the high operation after the age of fifty, does very well. My own suprapubic operations for stone (leaving out the first three by the old method, which were recorded in my first article) have given me a mortality of ten per cent.—that is, one death in ten cases. Two of my patients were between the ages of forty and fifty, the rest over fifty. Five of the cases were complicated by prostatectomy, and among these one died.

[1] Cabot's cases of old men (only 48 in number) are too few for much reliance to be placed upon them; the showing is very good, however, for the possibilities of lateral lithotomy in late life.

III. The third evidence of the table is startlingly clear, namely, that litholapaxy is plainly superior to every other method for the removal of stone, as far as its mortality is concerned, being twice as successful as the suprapubic method for children under fourteen, nearly four times as successful as the lateral or suprapubic for patients in middle life, and two and a half times as successful as the lateral, and five times as successful as the suprapubic method, for the removal of stone in old age.

But here a word is due to the general subject. The question must be asked, and honestly answered: Do we do our whole duty in removing stone in old age? Surely not, for the stone is generally phosphatic, and not at all a malady but only a symptom, and it does not cure the patient of his real disease to take the stone from him any more than it cures him to wash the pus out of his bladder. Therefore it is that these pleasant statistics have less value than they might otherwise seem to have, and we must look beyond the immediate relief which the patient is to get from the removal of one factor of his distress, to the catheter-life and general discomfort which may remain after the stone is taken away, just as it was before, excepting to a less extent.

It is not either my desire or my function to discuss the merits or demerits of prostatectomy; this is as yet an operation of the future, but I gravely propose it as a proper subject for inquiry, whether it may not be better, in spite of the risk, in a properly selected set of cases, to make a small stone in the bladder of an old prostatic subject an excuse for prostatectomy in the patient's interest. This question is by the way, and not apposite in the present discussion, to return to which it must again be emphatically stated that, as far as the stone itself is concerned, its removal may be effected more safely, in considering the question of mortality to the patient alone, by the crushing operation at any period of life than by any other operation if litholapaxy be feasible.

There is one set of cases in old men which needs a passing notice, namely, those prostatic conditions in which there is a very deep *bas-fond* or post-prostatic pouch, and in which, the stone being very small, litholapaxy is sometimes seemingly impracticable, as Buckston Browne demonstrated in an article in the Lancet for 1891. Yet even in these cases a skilful operator, with a properly selected instrument, may be able to take the stone out of the post-prostatic pouch, place it near the fundus, and putting the patient in Trendelenburg's position, complete the crushing even under difficulties.

Yet even when this is practicable, while it must be acknowledged that litholapaxy is the safer operation, it may be properly asked whether it is always the most expedient.

Before passing to the details of such matters as the preparation of the patient for his operation, and any new features of operative detail which modern innovations seem to furnish for comment, it may be well, in the presence of the modern *furor* which still occupies the profession relative to the performance of suprapubic cystotomy, to call to mind the operation of John Croft, recorded in the Lancet for 1887, of the skilful removal of two calculi, weighing together over four ounces, by the suprapubic route from an old man of seventy-two; and to emphasize the fact that this operation, at the date (1887) mentioned, was the first suprapubic section done at St. Thomas's Hospital since Cheselden

had abandoned the same procedure in England at the same hospital a century and a quarter before. That the suprapubic operation is eminently a better one now than it was in the days of Cheselden, no one need doubt; that its adaptability is very great in many cases of large stone, vesical tumor, and the like, may also occasion no question; but the mortality of the operation is still very high, and its popularity has led to its abuse even in good hands. Some modern statistics are exceedingly bad—such as those of Dittel, who in reporting his 600 cases of stone[1] includes 22 suprapubic cases with 5 deaths, a mortality of twenty-two per cent., while in his table of 487 cases, already cited in this article, the suprapubic mortality in 26 cases was 46.54 per cent.

Hunter McGuire, of Richmond, on the other hand,[2] in 26 suprapubic cystotomies records only 1 death, a mortality of less than four per cent. Vassini, in Vienna, has 21 cases with 1 death; Eigenbrodt,[3] in 38 cases 7 deaths; Buckston Browne, 13 cases and 4 deaths;[4] Mayo Robson,[5] 18 cases without a death, and Rydygier[6] must not be forgotten as having reported a successful intraperitoneal cystotomy, removing the catheter on the fifth day; but it must be remembered that Cabot's most modern statistics of 744 cases at all ages give a mortality of about nineteen per cent.

Preparation of the Patient.

The minute details of preparation for operation which were formerly so urgently insisted upon are now no longer deemed requisite, at least to the same extent. I refer here particularly to the preparation for litholapaxy. That this operation may be undertaken with a proper guaranty of success, it is only necessary beforehand that the calibre of the urethra shall be definitely estimated, so that the size of the tubes which may be used shall have been ascertained before the operation is commenced. It is not necessary to educate the urethra, as it was formerly called, to a tolerance of instrumentation, because no such education can so train the urethra that it will not resent the very considerable traumatism in the way of friction, to which it must be subjected during the operation of litholapaxy, by the frequent introduction and withdrawal of instruments. And if this traumatism affects only the surface, and if this surface and the fluids in which it is bathed are rendered aseptic, no serious reaction is likely to ensue whether the urethra has been previously educated to instrumentation or not. I have frequently operated upon a patient upon the day of his arrival in town from a considerable journey, and have never yet had to regret this seeming precipitancy. The rendering the contents of the bladder aseptic, however, is a matter of the first importance, and often in old chronic cases of vesical catarrh well-nigh impossible.

Guyon has emphasized the fact which many conscientious observers have demonstrated, that the urine in a healthy bladder is absolutely aseptic and contains no germs. Not so, however, the purulent fluid which often surrounds a urinary calculus; this is swarming with bac-

[1] Wien. med. Wochenschrift. Jan. und März, 1890.
[2] Medical News, March 7, 1890. [3] Zeitschrift für Chirurgie, Bd. xxviii., H. 12.
[4] British Medical Journal, March 15, 1890. [5] Sajous's Annual, 1891, E. 12.
[6] Wien. med. Wochenschrift, 16 Aug., 1890.

teria, and forms a mass of vegetable organic life of great variety and infinite pathogenic capacity. To destroy all of these bacteria is often impossible, but the more nearly it is accomplished the more certain are we to observe moderate reaction after a crushing operation.

The internal means (which are now relied upon with more or less confidence by various surgeons and have been mentioned in my former article) are the use of benzoic acid and the benzoate of sodium, preferably the latter on account of its less irritating effect upon the stomach. The salicylate of sodium and salicylic acid, and even salicin, any or all of these in rather free doses, are believed to moderate the putrefactive degeneration which occurs in some conditions of vesical catarrh, notably in an atonied bladder with a phosphatic calculus. Salol up to fifteen-grain doses three times a day sometimes has a very pronounced power in sweetening the contents of the bladder, while in other instances it is entirely useless.

This drug has the disadvantage that it sometimes interferes seriously with digestion, and even in doses smaller than fifteen grains (possibly even in a five-grain dose) will occasionally produce depressing symptoms, and the olive-green smoky color associated with carbolic-acid poisoning will appear in the urine. If forty-five grains a day does not produce the effect desired, as evidenced by examining the urinary excretion, no greater amount will do it. Of course, if the stomach is upset and the green color appears in the urine, this drug is inappropriate and should be discontinued.

Boric acid has of late years been highly extolled in doses as high as fifteen grains three times a day; this also sometimes upsets the stomach, and I think that if ten-grain doses will not clear the urine no greater amount will do so.

The biborate of sodium, ordinary powdered borax, up to a one-drachm dose, in milk, three times a day, will sometimes do more than any of the drugs enumerated above. I have found occasionally that a combination of some of the foregoing medicines has been effective where no one drug alone has seemed to answer as well; as, for instance, a capsule of four or five grains each of boric acid and the benzoate of sodium, or of borax and the benzoate of sodium. The latter capsules are a little the easier to digest, but I have heard patients complain that they get moist very readily when carried about in a box.

Saccharine, in five-grain doses three times a day, a remedy introduced by Dr. A. H. Smith of New York, seems to possess a sweetening influence in some cases; and the oil of wintergreen, which may be placed in ten-minim capsules, giving ten or twenty minims at a dose three times a day, also possesses a moderate power in the sterilizing effect which it is the object of all these medicines to produce upon the contents of the bladder.

These internal medicines, however, are very uncertain agents in sterilizing the bladder contents, and reliance must more often be placed in direct local means of disinfection than in this roundabout method. The washing of the bladder and urethra at the time of operation with dilute peroxide of hydrogen; with strong boric-acid solution; with bichloride of mercury, from 1–30,000 up to 1–3000—all of these means find acceptance in good quarters and have considerable value, more or less positive, according to the activity of the agent employed.

The two substances which seem to me to possess the greatest amount of value in this particular, are saliclyic acid and the nitrate of silver; the former substance has found a vigorous champion and active advocate in the person of Dr. Bryson, of St. Louis, who has demonstrated its claims in several written articles, and has especially promulgated his views upon its value in the preventive treatment of urethral fever, in an admirable contribution to the literature of that subject.[1]

This substance can be used perhaps most readily in the form of Thiersch's solution, which may be made upon the spot, at a moment's notice, by dissolving a powder composed of a drachm of salicylic acid and half an ounce of boric acid in a quart of hot water. With this the urethra and bladder may be frequently and thoroughly irrigated just before commencing a crushing operation, with a certainty that this remedy will dissolve out the mucus from hidden places, and wash away offensive glutinous material, perhaps more satisfactorily than any other. The bichloride of mercury, in solution of from 1–20,000 to 1–10,000, according to the presumptive sensitiveness of the patient, is a local wash upon which also I place considerable reliance; but where there is much viscid mucus, I prefer the salicylic acid-combination.

The nitrate of silver finds its chief advocate in Professor Guyon, who maintains that its use in the deep urethra after any traumatic irritation of that canal—causing such lesion, for instance, as that produced by the use of sounds—will prevent urethral fever; and it is his habit, both before and after the conclusion of a crushing operation, to flush out the urethra and irrigate the bladder with a solution of the nitrate of silver, one grain to the ounce or thereabouts. I have used this substance in the way described with apparently most gratifying results, both in stone cases and in others requiring operative manœuvres upon the urinary tract. The obvious objection to its use is the irritating effect which it leaves behind, causing certain sensitive patients to strain unnecessarily for several hours after an operation, unless prevented by the administration of an amount of anodyne which would not otherwise be called for.

The question of sterilization of instruments and of the aseptic performance of operations involving the bladder, is one which often comes up for discussion, the intelligent questioner naturally asking why all this care should be taken to sterilize the secretions and keep a wound surgically pure, when the bladder is cut into either above the pubis or in the perineum, when it is quite obvious that by no possibility can the wound be kept surgically pure after the operation, bathed and kept constantly moistened as it must be, and perhaps the dressing as well, by a fluid so capable of rapid degeneration and so full of microbic life as decomposing urine.

In answer to this it may be justly replied that the operator who cuts open the bladder one day may attack the kidney or some other organ the next day, and that we are all such creatures of habit that, unless we adopt an operative technique which we apply to all cases, we shall certainly neglect, sooner or later, some necessary precaution in a case where such neglect might be fatal. And even if the operator could afford himself the license of neglect in a case which in his judgment would justify ordinary carelessness, still he should allow no such license

[1] Journal of Genito-Urinary and Cutaneous Diseases, Sept., 1892.

to his assistants and nurses, because their dependence upon routine habit must be, and should be, even more crystallized than his own. Hence it is proper, in all operations upon this region involving a use of the knife, to scour the integument in the most scrupulous manner, to sterilize the instruments, and to adopt and maintain all the requirements of aseptic surgery even down to their minutest details. If these precautionary measures are carefully attended to, everything will have been done that possibly can be done to avert pernicious urinary fever with its attendant suppression and other disastrous sequences, and no further call need be made upon such uncertain adjuvants as were formerly more or less relied upon—pilocarpine, quinine, aconite, or any other internal remedy.

In cases of weak heart I have no possible question of the value of the subcutaneous injection of one hundredth of a grain of atropine just before the anæsthetic is administered. This certainly moderates shock and sustains the heart. Also I prefer personally, in operating upon any case with damaged kidney, to rely upon chloroform rather than ether for the production of anæsthesia, believing, as I do, that if atropine and a little morphine are used, the heart is protected during the operation, and feeling confident that the kidney is spared much unnecessary work which it would have to do in the subsequent elimination of ether, were that substance employed.

Diuretin, a drug which has been spoken of as of value in preventing urinary fever and secondary renal congestion, and which at one time I looked upon favorably (led to this conclusion by certain apparently convincing facts), I now have absolutely discarded, placing no reliance upon it whatever in the way of its power to forestall urinary fever.

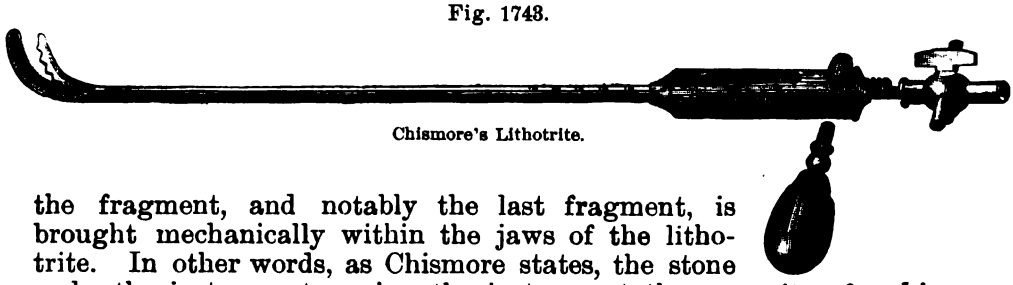
Operative Details.

Lithotrity as an operation may as well be dropped once and for all; it is simply a part of the modern and better operation of litholapaxy, and is included in it. The operative manœuvres for the effective performance of litholapaxy are still identically what they were when this masterly operation was introduced. Every operator has some little trick of his own which he learns in the manipulation of the instruments with which he is most familiar, and which he probably could not communicate to another if he tried. I do not know how it is with other operators, but the broadening influence of time has relieved me of the necessity of relying upon my own or upon any other man's lithotrite, and I generally have several with me, and employ one or the other, according to the particular indications furnished by the patient or the stone in each individual case. The fenestrated lithotrite, however, has each year gained more and more friends, and is now constantly preferred in India, where so much litholapaxy is performed, and in England on account of its superiority over the non-fenestrated instrument.

The most important new device among the lithotrites is that of Chismore, of San Francisco (Fig. 1743), with which he has done all of his crushings, achieving a statistical success not equalled, as far as I know, by any one in this country or in England, and probably nowhere out of India—that is, his sixty-three consecutive cases have all been

successful. This instrument is furnished with a tip, by means of which fluid can be thrown into the bladder while the instrument is in place, and it is alleged that by the commotion in the waters thus produced,

Fig. 1743.



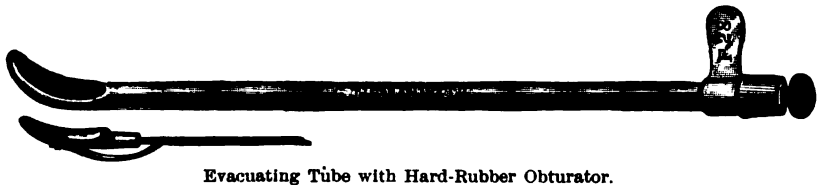
Chismore's Lithotrite.

the fragment, and notably the last fragment, is brought mechanically within the jaws of the lithotrite. In other words, as Chismore states, the stone seeks the instrument, saving the instrument the necessity of seeking the stone.

Dr. W. S. Forbes introduced another improved lithotrite to the profession at the meeting of the American Surgical Association in 1894.

Another satisfactory instrumental improvement is the hard-rubber obturator (Fig. 1744) pressed up into the eye of the straight tube by means

Fig. 1744.

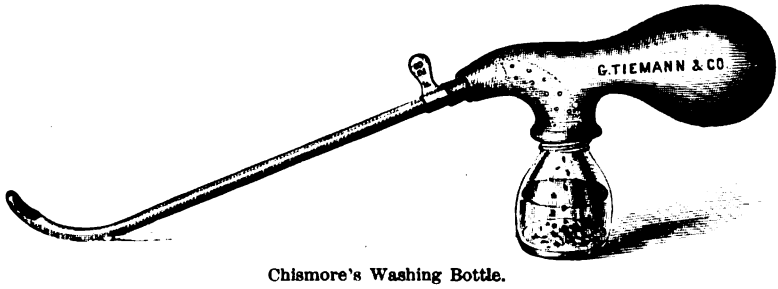


Evacuating Tube with Hard-Rubber Obturator.

of a spring, so that its introduction is effected with much less friction than could formerly be the case. My own straight tube with the soft-rubber flexible tip I have abandoned, because the perishable quality of soft rubber makes it particularly unsuited for this purpose, and really this tip has no advantage over others in use. The straight tube which I have advocated, with a Mercier metallic tip, has proved a very satisfactory instrument in my hands.

It is necessary to chronicle the birth of a new washing-bottle, which

Fig. 1745.



Chismore's Washing Bottle.

seems to act upon a new principle and has been devised and perfected by Chismore. Fig. 1745 represents it. It is light and easy to handle,

is less expensive than any of the other bottles, and seems to commend itself for general adoption. My experience with it, however, is, I may say, limited, and I can only give its picture with my favorable impression of its work thus far.

SPEED IN OPERATING.—Good, not rapid, work is what modern surgery requires, and although the term litholapaxy is often made interchangeable with rapid lithotrity, still no operator, particularly no young operator, can afford to aim at rapidity, and must accept it as a fact that rapid lithotrity done slowly is much better than the same operation when pushed with undue haste. It is rapid enough in any case if the operator is competent, and the protection given to the soft parts by the gentleness of manipulation in the slow operation much more than compensates for the few minutes which might be gained by a more rapid execution of the operative manœuvre.

LITHOTOMY.

This operation, formerly so dreaded and so much revered, is becoming a classical memory to some and a novelty to others; it must always remain as a brilliant surgical procedure to be applied in properly selected cases, but its usefulness for the liberation of stone is far less than it formerly was. Children, formerly furnishing us a fertile field for brilliant and successful lithotomy, will in the near future be entirely cared for by litholapaxy, excepting in those cases of foreign body and excessively large calculus that must be ministered to by the high operation. The perineal route will soon be entirely abandoned as far as children are concerned, since children have no vesical *bas-fond* and no vesical disease that will not get well spontaneously when the foreign body is removed. For the neck of the bladder in the child is its most dependent portion, and therefore drainage is perfect, while atony and trabeculization are practically out of the question, and there are no cysts or pouches, such as the old man has; and in such conditions what more can be demanded of the surgeon, for a child with stone, than to remove the foreign body and let the empty viscus take care of itself. This, litholapaxy can perfectly effect. Possibly in some rare cases where prolonged drainage may be demanded for ulcerated surfaces, the perineal operation may still be called upon, but with greater and greater rarity as time goes on.

And the same conclusions, or nearly the same, apply to the adult male, with certain exceptions for such irregularities as tumor, tubercular disease, foreign body, or irregularities necessitating digital or ocular exploration, in which case the perineal or suprapubic cutting operation may need to be called into use rather than the crushing manœuvre.

Still, in properly selected cases, it is well to emphasize here the conviction which has gained ground in all places of late, namely this: that no large stone should be extracted under any circumstances through the perineum, that is, unless it has been previously broken up. Anything over an inch and a quarter in diameter at the outside, it may safely be said, if taken out whole should come away above and

not below the pubic symphysis; and from this limit I personally should be willing to cut off the last quarter of an inch.

THE SUPRAPUBIC OPERATION.—The longitudinal incision in this operation is still adhered to, excepting in a few instances where the complication of a tumor makes the transverse opening preferable. The question of suturing the entire wound is an open one. It probably will be done more often in the future than it has been in the past, and there is no legitimate objection to it if it be properly done; and certainly if union of the wound is effected, it hastens the getting up of the patient. Most surgeons, however, only partially close the bladder, and insert one or two drainage-tubes, or leave it entirely open.

The use of the Petersen bag with very moderate distention, say five or six ounces, does not seem to increase the danger of the operation, but it is unnecessary and I have discarded it. The same may be said about the distention of the bladder, five or eight ounces of fluid being usually found enough. Of course, in some thin-walled flabby bladders a considerably greater amount of fluid may be thrown in, when it goes easily, but a competent operator can do as well with from five to eight ounces in the bladder as with a greater amount.

Many of the instruments pictured and described in my former article may now be relegated to dusty cabinets. Such are the *lithotome caché*, the rectangular staff, the *éclateurs*, and various perineal stone crushers, the gorgets, and some others. The armamentarium of the lithotomist has been simplified in modern surgery rather than made more complicated.

AFTER-TREATMENT.—The after-treatment of all these operations is much the same as it was ten years ago, more scrupulous attention, however, being now given than formerly to drainage, irrigation, and surgical cleanliness, and with proportionately better results.

INJURIES AND DISEASES OF THE URETHRA.

BY

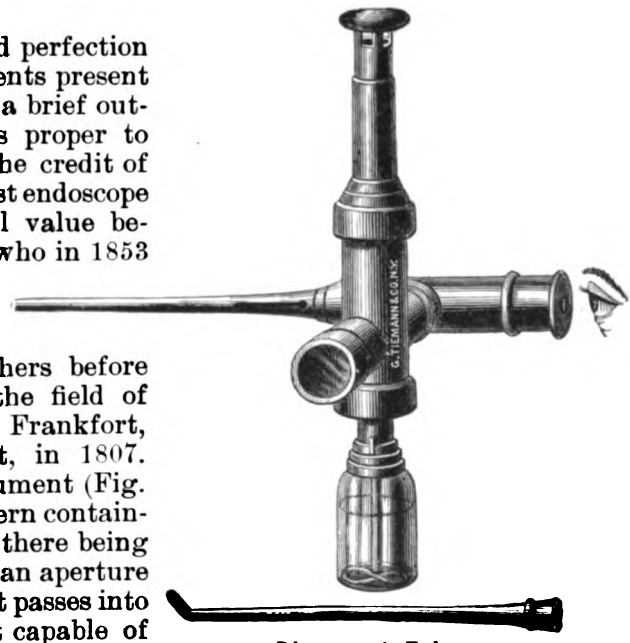
THOMAS R. NEILSON, M.D.

PROFESSOR OF GENITO-URINARY SURGERY IN THE PHILADELPHIA POLYCLINIC, SURGEON TO THE EPISCOPAL HOSPITAL AND TO ST. CHRISTOPHER'S HOSPITAL, PHILADELPHIA.

EXPLORATION OF THE URETHRA AND BLADDER.

ENDOSCOPY.—Direct visual examination of the urethra and bladder has, through the aid of the perfected instruments in use at the present time, come to be recognized as a step of the greatest value in the diagnosis and treatment of the pathological states of these organs. Indeed, in many instances, an exploration of the urethra or bladder might justly be considered incomplete without the employment of the endoscope.

Fig. 1746.



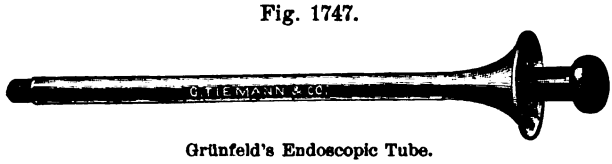
Désormeaux's Endoscope.

The development and perfection of endoscopic instruments present an interesting history, a brief outline of which it seems proper to give in this place. The credit of having produced the first endoscope which was of practical value belongs to Désormeaux, who in 1853 brought his instrument to the notice of the Academy of Medicine of Paris, although others before him had worked in the field of endoscopy, Bozzini, of Frankfort, having been the first, in 1807. The Désormeaux instrument (Fig. 1746) consists of a lantern containing a petroleum lamp, there being on one side of the case an aperture through which the light passes into a tube secured to, but capable of being freely turned upon, the case. In the tube is a lens which condenses the light, and, set at right angles to the long axis, reflects the light in the line of the axis of the endoscopic tube or speculum. This latter is attached to one end of the cylinder, while in the other is an aperture through which the observer looks.

After some years of work with this instrument, Désormeaux published a book on the subject of endoscopy, entitled "L'endoscope, et ses applications au diagnostic et au traitement des affections de l'urèthre et de la vessie." This was in 1865. It was found that this instrument possessed the double disadvantage of being cumbersome and of emitting considerable heat.

Haken, of Riga, in 1862, very much simplified the endoscopic process by calling into service the ordinary head-mirror, and, getting his illumination from light reflected by it, did away with the clumsy lantern of Désormeaux. This step led to the adoption by different investigators of a variety of urethral tubes differing both as to the material of which they were made and the shape of the ocular end. It also distinctly separated urethral endoscopy, or *urethroscopy*, from vesical, or *cystoscopy*.

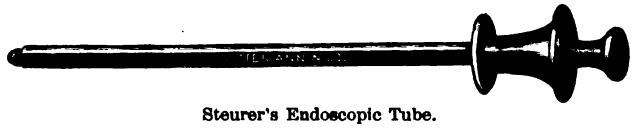
Fig. 1747.



Grünfeld's Endoscopic Tube.

The materials from which the urethroscopic tubes have been made are metal, hard rubber, and glass. The metallic tubes are sometimes made of silver, on account of the power of that metal to resist to a great extent the action of corrosive fluids sometimes employed in the treatment of urethral lesions. Tubes made of hard rubber have the disadvantage of being smaller in calibre than metal ones of a like circumference, it being necessary that their walls should be thick in order to prevent their being too brittle. For glass tubes the claim has been made that they can be more easily and thoroughly cleaned than those of other materials, but the undeniable possibility of their breaking, and so inflicting some injury upon the urethra, practically outweighs this advantage. In addition to those of a cylindrical form, specula of the bivalve type have been devised, and are preferred by some surgeons.

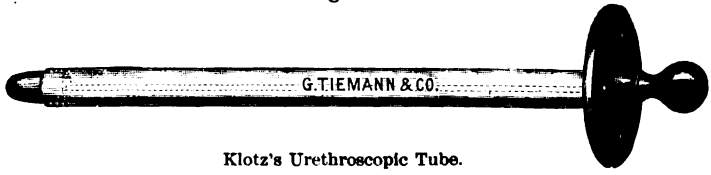
Fig. 1748.



Steurer's Endoscopic Tube.

Grünfeld, who has contributed largely to the literature of endoscopy, uses urethral tubes made funnel-shaped at the ocular end, for the purpose of securing the entrance of all the light rays possible into the tube.

Fig. 1749.



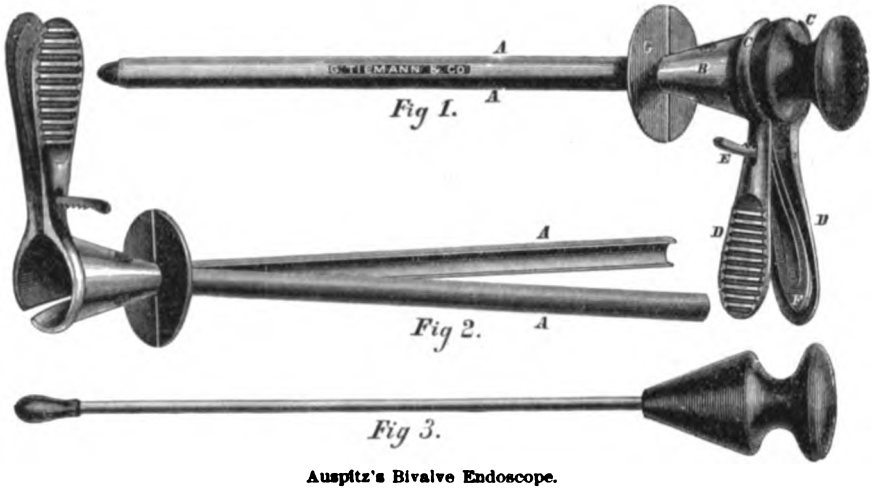
Klotz's Urethroscopic Tube.

(Fig. 1747.) Steurer modified Grünfeld's tube by placing a disk at the point where the funnel joins the cylindrical portion of the tube, the purpose of the disk being to prevent the discomfort to the patient of having the meatus overstretched by the funnel being forced into it during the examination. (Fig. 1748.)

Klotz again modified the tube by leaving off the funnel-shaped end, simply retaining the disk attached to the extremity of the tube. (Fig. 1749.)

Of the bivalve variety, Auspitz has produced one, the sides of which are separated by pressing together the two parts of the handle. The

Fig. 1750.

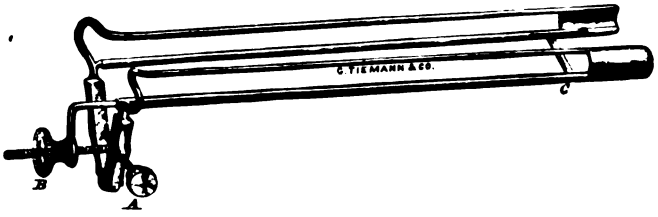


Auspitz's Bivalve Endoscope.

instrument is introduced, like the cylindrical endoscopes, with an obturator in place. The objection to it, which is very potent, is that when opened its parts are not parallel, the vesical or distal ends separating, while the ocular end does not. For this reason, illumination of the deeper portion of the urethra cannot be perfectly effected with this instrument, the width of the beam of light being limited to the diameter of the orifice at the proximal extremity. (Fig. 1750.)

F. Tilden Brown,[1] of New York, has given to the profession two excellent bivalve specula, one of which is made of wire, with open

Fig. 1751.



F. Tilden Brown's Wire Urethral Speculum.

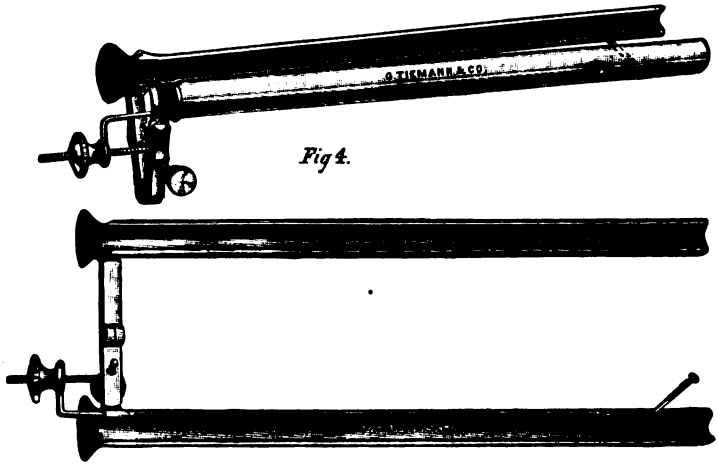
sides, while in the other the sides are solid. (Figs. 1751, 1752.) Both are so arranged that the sides, when separated by means of screw attachments, remain parallel. For the wire speculum is claimed the advantage that it gives a very much greater exposure of the urethra than does the endoscopic tube, and that it affords a view, therefore, of the walls of the urethra for its entire length, as well as at its extremity.

[1] Journ. Cutaneous and Genito-Urinary Dis., vol. ix., 1891, p. 240 *et seq.*

ELECTRIC ENDOSCOPY.—The first to apply electrical illumination to endoscopic investigation was Nitze, his earliest efforts in this direction having resulted in the production of his cystoscope, and soon afterward of his urethroscope. The latter instrument was employed clinically in 1877 by Oberländer, of Dresden, who has made some valuable contributions to the study and development of endoscopy. The adoption of electricity as the source of light was an important step, and a great improvement over illumination either by sunlight or artificial light reflected from the head mirror.

The name of Leiter, of Vienna, which has since figured so prominently in the improvement of endoscopic instruments, became associated with the subject in 1879, when Dr. Nitze took to him his cystoscope for the purpose of having some mechanical difficulties overcome. In the Nitze urethroscope, as well as the cystoscope, the illumination is

Fig. 1752.

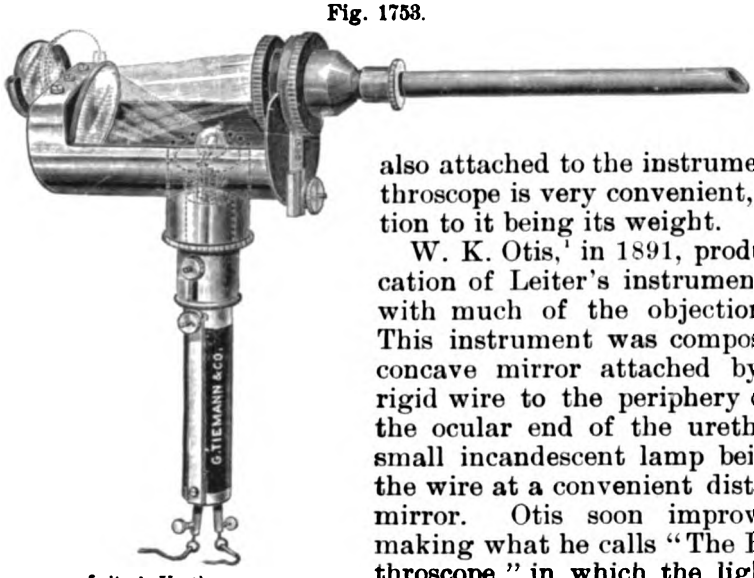


F. Tilden Brown's Solid Bivalve Urethral Speculum.

obtained from a loop of platinum wire placed at the distal end of the tube. The heat given out by this is so great as to require the construction of the instruments in such a way as to permit the circulation in the tube of a constantly moving stream of cool water.

This difficulty was relieved by the invention of Edison's incandescent lamp, and its adaptation, in 1887, to the urethroscope by Leiter, who thus produced an instrument which has led to much study and investigation of urethral disease. In Leiter's instrument a "mignon" incandescent lamp, mounted upon the end of a hard-rubber handle, is placed in a gutter, or semi-cylinder, of metal. At one end of this latter is a small concave mirror, fixed at an angle, and so adjusted as to direct the rays of the light reflected from it into the urethral tube, which is adjustable to a funnel-shaped collar at the opposite end. The wires from the battery are attached to binding posts at the lower end of the handle, and the current is under control of the observer through the agency of a key placed along the side of the handle. The eye of the observer looks from behind across the top of the mirror, through the funnel opposite to it, and down the tube. A lens, changeable to suit any

Fig. 1753.

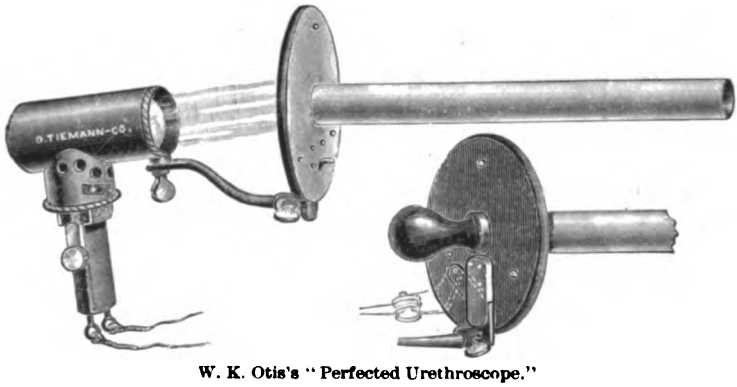


Leiter's Urethroscope.

defect in the accommodation on the part of the observer, is also attached to the instrument. This urethroscope is very convenient, the one objection to it being its weight. (Fig. 1753.)

W. K. Otis,[1] in 1891, produced a modification of Leiter's instrument, doing away with much of the objectionable weight. This instrument was composed of a small concave mirror attached by means of a rigid wire to the periphery of the disk at the ocular end of the urethral tube, the small incandescent lamp being secured to the wire at a convenient distance from the mirror. Otis soon improved on this,[2] making what he calls "The Perfected Urethroscope," in which the light, instead of being reflected from a mirror, is condensed by passing through a lens. In a metal tube or cylinder, 1¼ inches in length and one-half inch in diameter, one end of which is closed while into the other is inserted a plano-convex lens, is introduced through a tube or elbow on the lower side, and near to the closed end, the small incandescent lamp. The handle of the instrument is small, consisting of a piece of hard rubber one inch in length by one-half inch in width. The current is controlled by a thumb-screw switch on the side of the handle. This illuminator is connected to the urethral tube by a piece of stiff wire 1½ inches long, a hinged joint being at either end. For this instrument are claimed: the exclusion of extraneous light, a more ready access to

Fig. 1754.



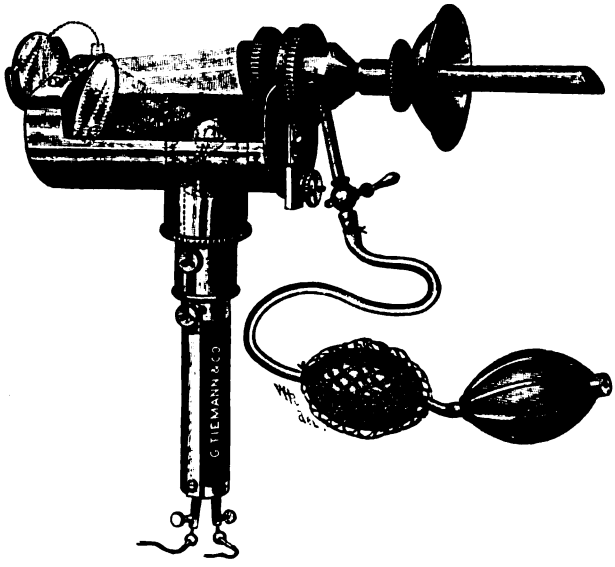
W. K. Otis's "Perfected Urethroscope."

the urethral field, increased illumination, diminution in the distance of the eye from the mucous membrane to be examined, compactness and lightness—its weight being less than one ounce—and, lastly, simplicity.

[1] Journ. Cutaneous and Genito-Urinary Dis., 1892, vol. x., p. 164.
[2] New York Med. Journ, 1892, vol. lvi., p. 677.

AËRO-URETHROSCOPE.—To von Antal is due the credit of having devised a urethroscope designed to effect exposure of the urethral surface by inflating the channel with compressed air. This is accomplished by means of a pressure bulb attached to the instrument. A glass diaphragm in the funnel-shaped end of the lamp box, together with a concavo-convex cup into which the glans penis fits near the proximal end of the urethral tube, prevents the escape of the air. Another instrument, similar to von Antal's, has been devised by Heuer. Both of these instruments, while affording a good exposure of the urethra, are limited in their usefulness to the field of diagnosis, the glass diaphragm above mentioned preventing their being employed for purposes of local treatment.

Fig. 1755.



Fenwick's Aëro-Urethroscope.

This defect has been remedied by Mr. E. Hurry Fenwick.[1] His improved aëro-urethroscope is so constructed that the glass diaphragm closing the tube can be removed, permitting the use of the instrument for therapeutic purposes. This form of urethroscope has not yet attained very great popularity, in this country at least. One advantage connected with it, however, to which Fenwick calls attention,[2] seems worth mentioning. This is the facility with which the canula can be moved along the urethra, without causing pain, in consequence of the absence of friction at the end of the tube, the urethral walls being pushed away from it by the air inflation. (Fig. 1755.)

EMPLOYMENT OF THE URETHROSCOPE.—In order to be prepared to meet with the varying capacities of different urethræ, it is necessary to be provided with a number of tubes or canulæ, varying both in length and calibre. Thus, a set should comprise tubes ranging in circumference from No. 20 to No. 32 or 34 of the French scale, and from 3 to 5½ or 6 inches long. Of course it is obvious that, for a given examination, the largest tube that will enter the urethra should be chosen, and furthermore that the best illumination will be obtained through a short tube of large diameter. Should the meatus be disproportionately small, it should be enlarged with a tenotome so as to admit an instrument of suitable size. The tube should be warmed before being used,

[1] British Med. Journ., Dec. 31, 1892.
[2] Epitome of Urinary Surgery. Bristol, 1894.

and should be lubricated with either petrolatum, borated glycerin, or carbolized oil (1–40). It is then gently inserted as far as it is intended to explore the channel, usually, at first, to the posterior limit of the bulbous portion. During the insertion of the tube the penis should be held at about a right angle with the body. The introduction being accomplished, the obturator should be carefully withdrawn, and the light attached or directed into the tube or speculum. It will be observed that the urethra, over the end of this, closes in in the shape of a funnel or cone. From the periphery to the apex of this funnel the urethra, in its natural tendency to contract, is thrown into folds, which converging, cause the lumen to appear as a depressed spot or line, known as the "central figure" (Grünfeld). Should it be intended to explore the posterior urethra, some difficulty may be encountered in introducing the tube at the entrance to the membranous urethra. This may be overcome by depressing the distal end of the tube, carrying the penis well down between the thighs, just as is done in introducing the evacuating tubes in the operation of litholapaxy. There is some difference of opinion as to the necessity for anæsthetizing the urethra with cocaine preparatory to examination. Fenwick[1] strongly advocates its being done, and says, in his excellent work on Electric Endoscopy, that he makes it "a rule to examine under the influence of cocaine," and, having employed it in a very large number of cases, many times in twenty-per-cent. solution, without any bad results, that he believes "the apprehensions of dangerous symptoms following its use upon the urethra to be quite unfounded."

Outside of the question of the danger of the possible toxic action of the drug, however, there seems to be some force in the argument that cocaine may alter the appearance of the surface of the urethral mucous membrane, blanching it through its constricting influence upon the capillaries. Agreeing with Klotz,[2] therefore, I believe that, except in cases of supersensitive individuals or in instances where there exist some specially hyperæsthetic lesions or areas of the canal, it is probably better not to use the cocaine. If it should be necessary to employ it, the strength of the solution need not exceed four or five per cent.

ENDOSCOPIC APPEARANCE OF THE NORMAL URETHRA.—For practical purposes the division of the urethra into two parts—the anterior or spongy, comprising all from the junction of the bulbous with the membranous portion forward, and therefore being about six inches in length, and the posterior, including the membranous and prostatic portions—is most convenient. In inspecting the urethra, the anterior portion should be examined first. In the spongy portion, beginning at the bulbous region, it will be observed that the mucous membrane at the end of the tube lies in heavy folds. As the tube advances outward, the mucous membrane appears as a funnel, with less distinct folds running towards the apex, and the lumen is a slit directed transversely, or nearly so, until near the fossa navicularis, where it becomes either crescentic or triangular in shape, with the base of the triangle or the

[1] Electric Examination of the Bladder and Urethra, 2d edition. London, 1889.
[2] System of Genito-Urinary Diseases, Syphilology, and Dermatology, Article on Endoscopy. Edited by Morrow. New York, 1893.

concavity of the crescent upward. From this point forward the lumen becomes a vertical slit, as it is at the meatus.

The color of the mucous membrane varies to some extent with the individual, being of a decided pink in those of fair complexion, while in those of darker hue it is bluish or dull pink. In the glans, near the meatus, it is yellowish or of a dull blue tint. The surface of the mucous membrane is usually smooth and covered with a normal gloss. It often presents a finely striated appearance. What seem to be fine pits or pouches, that are sometimes discerned, are the lacunæ of Morgagni.

As to the posterior portion of the urethra, first, the color of the mucous membrane of the prostatic portion is deeper than it is anteriorly, being a distinct red. The lumen at the meatus urinarius internus is transverse, with radiating folds at either end. The cone or funnel is shallow. On withdrawing the tube, the verumontanum urethræ will be observed first as a slight prominence on the floor of the urethra, which gradually increases in size as the instrument moves outward, until it projects noticeably into the urethra, and gives thereto a crescent-like figure. In advance, still, is a small slit showing the position of the sinus pocularis, and on either side of the verumontanum can be seen the furrows into which the ejaculatory ducts open, though the latter cannot be demonstrated without great difficulty. In the membranous portion the color of the mucous membrane is not so dark as in the prostatic, being more of a bright pink. The lumen is a vertical slit, and the cone regular in outline.

Berkely Hill[1] calls attention to the frequent changes in the shape of the prostate during examination, even when the patient is lying quite still, the muscles surrounding the part easily affecting it. It is always a more or less difficult matter to obtain a satisfactory examination of the prostatic and membranous urethra, and the very great ease with which annoying bleeding of the mucous membrane may be provoked is often a source of great embarrassment to the surgeon, and may even lead to mistakes in diagnosis. The instrument should be used in this part of the canal with the utmost gentleness.

USES OF THE URETHROSCOPE.—Aside from its use in the diagnosis and treatment of chronic inflammatory conditions of the urethral mucous membrane (gleet), the discussion of which subject belongs under another heading in this work, the urethroscope is a most convenient and valuable aid in cases of neoplasm of the urethra, foreign bodies, or impacted calculi, in the discovery of false passages, or in the diagnosis of stricture. The latter can be diagnosticated undoubtedly by other well-known means, but there are cases in which much can be learned from a visual inspection of the infiltrated or strictured area. If the urethra is in a normal condition, it will fall in evenly behind the tube, as the latter is withdrawn, whereas if there be present areas of chronic inflammation or infiltration, leading to stricture, the manner in which the canal closes beyond the tube will be noticed to be quite different—the walls falling together unevenly, and by sudden starts. The use of the urethroscope will be alluded to again under the subjects of Stricture and Neoplasms.

In conducting urethroscopic work, certain instruments will be found

[1] Chronic Urethritis, p. 5. London, 1890.

necessary. First, cotton carriers, or applicators. These will be constantly needed for cleansing the surface of lubricating material, or of blood or discharges, as well as for the making of applications. The best type of carriers are those made of good, stiff wire, roughened at one end, similar to, though longer than, those used in ear and throat work. Applicators made of heavier wire, split at one end, with small tooth-like points for seizing the tampon, and a sliding ring for holding it shut, are often used, and, again, others made of wood answer the purpose very well. In fact the wooden applicators have much to commend them, in that they are so inexpensive that they can be thrown away after being once used. Besides applicators, it will be convenient to have at hand a small curette, scissors, forceps, and a small wire écraseur or snare, while, if the bivalve wire speculum should be employed, Brown's urethral mirror[1] and urethral digit—the latter being a probe with movable end for exploring the surface of the urethra by means of touch—will be found serviceable.

CYSTOSCOPY.—The Nitze electric cystoscope, made by Leiter in 1879, already alluded to, is an instrument resembling in shape a vesical calculus sound, size 21 F. In the extremity, or beak, is placed a platinum loop lamp. This is enclosed in a cap, having a small aperture closed with a plate of rock crystal. The shaft, or tube, which is about five inches in length, contains a system of lenses for magnifying the image seen by the observer, as well as one insulated electric conductor (the metal of the tube itself serving as the other), and two small tubes for the conveyance of water to carry away the intense heat developed by the lamp. It is elbowed, and, at the position of the bend, has an opening in which is placed a prism. The eye-piece, or proximal end, has upon it the tubes to which the water cooling system is attached, and binding posts for the battery connections. The great heat evolved by the lamp in this instrument, and the necessity of a mechanism for cooling it by water, constitute serious objections to it.

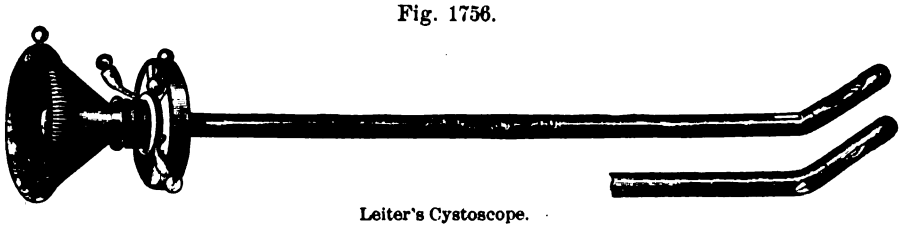
The improvement of adapting the Edison incandescent lamp to the male cystoscope was not made for several years after the date of Nitze's instrument. In the mean time Nitze had had a disagreement with Leiter, and sought the skill of Hartwig, of Berlin, for the construction of his improved cystoscope. Leiter, too, was working in the same direction, and, in 1887, two incandescent lamp cystoscopes, one by Nitze (made by Hartwig), and the other by Leiter, were presented to the profession. That of Nitze resembles in general appearance his original instrument. In the end of the beak, which is a hollow silver cap, and can be screwed on and off, is placed a small incandescent lamp, which closely fills it. A small oval opening permits the escape of the luminous rays. The shaft differs from that in the earlier instrument in that it does not contain tubes for conveying water to and from the end of the instrument. At the bend of the elbow is, as before, a refracting prism inserted in an aperture. The eye-piece is simplified by the omission of the water connections, and has upon it only the binding posts for the battery wires, and a key controlling the circuit.

Leiter's Cystoscope.—This instrument is very much like that of Dr. Nitze in appearance. It has some advantages over it, however. The

[1] F. Tilden Brown, loc. cit.

beak is hollow and can be removed entire, and has a larger aperture in which is inserted a pane of rock crystal for the transmission of the light, permitting, therefore, better illumination. In case the little lamp should be broken, or should be rendered useless by the burning out of the carbon filament, it can be easily replaced by removing the beak or hood, and simply lifting it out of two small sockets into which

Fig. 1756.



Leiter's Cystoscope.

its terminals fit. Both conductors go within the tube or shaft of the instrument, and are connected with the little sockets for the lamp, and so complete the circuit. (Fig. 1756.)

Fenwick [1] improved upon Leiter's instrument by having the hood made with several apertures on the side opposite the window, the object being to permit free contact of the fluid in the bladder with the lamp, and so to keep the hood cool. He also placed upon the ocular end a ring or rotary collar bearing the binding screws for the battery wires, and improved upon the key for opening and closing the circuit.

These are the typical cystoscopes in use at the present day. The aperture for the light and the refracting prism spoken of are usually placed on the side of the concavity of the bend. Some instruments are made in which they are upon the convex side. These latter are intended for use in cases of enlarged prostate.

Certain modifications of detail of the cystoscope have been made at various times, but the only one that will be alluded to here is that of Brenner. In this instrument there is, in addition to the main or telescopic tube, a small tube passing along the outside of the shaft of the instrument. The purpose of this tube is to permit renewal of the fluid in the bladder during examination, and also to make possible catheterization of the ureters. No great success, however, has thus far attended efforts in this last-named direction, as far as the male bladder is concerned.

Employment of the Cystoscope.—When it is intended to make a cystoscopic examination, the bladder should contain from four to six ounces of urine, and, unless this be clear, a transparent fluid, such as boric-acid solution, should be injected, after withdrawing the urine and washing out the bladder. The urethra must be free from stricture, or at any rate of such calibre as will not preclude the possibility of passing the cystoscope, the size of which is 22 F. The patient should be recumbent, or even in the lithotomy position. Before introducing the instrument the current should be turned on and the lamp tested.

The question may arise whether it be necessary to employ anæsthesia, either local or general. As to the latter, it need rarely be resorted to,

[1] Op. cit., p. 43.

save in cases in which the bladder is extremely irritable. Fenwick,[1] whose experience with the cystoscope has been very great, gives the following conditions under which he employs anæsthesia: "(*a*) in females, for delicacy; (*b*) in tuberculosis, or similar cases where the prostatic urethra is extremely sensitive; (*c*) in order to make a leisurely prognosis of a discovered growth so as to determine the expediency of operating." Willy Meyer, of New York, in his excellent article on Cystoscopy in Morrow's System of Genito-Urinary Diseases, Syphilology, and Dermatology, says about narcosis that "the cases are comparatively rare in which we have to resort to its help."

As to local anæsthesia, with cocaine, this bears the indorsement of Nitze and Fenwick. The latter[2] says that, when necessary, a drachm or more of a twenty-per-cent solution of cocaine may be injected into the bladder. He has never met with any untoward experience with it, and says that he has "used injections of the drug continually in large out-patient practice, and has *never* seen any case presenting symptoms of so-called cocaine poisoning." Meyer[3] has not been so fortunate, having had, after a large experience in the use of cocaine, a case in which the patient narrowly escaped death after the injection of 50 cubic centimetres of a two-per-cent. solution. He also quotes a fatal case of Albarran's, in which the injection of two ounces of a one-per-cent. solution was followed, within a few minutes, by convulsions and death. In view of these experiences, the possible danger of cocaine should be borne in mind. While the question of anæsthesia must be settled by the circumstances of the individual case, the majority of examinations may be made without resorting to it.

The instrument, having been introduced, should first be carefully moved so as to be sure that its beak is not in contact with the walls of the bladder. This being ascertained, the exploration of the organ may be begun. By first maintaining the beak of the instrument directed upward, then turning it to one side, and then to the other, all parts of the surface, except the trigone, will be brought successively into view. By now lowering the handle and reversing the position of the beak, the trigone, together with the orifices of the ureters, will be seen, and the inspection may thus be completed.

The mucous membrane of the bladder in health is of a yellowish or reddish-yellow color. Small blood-vessels can be seen running through it in a tortuous manner, and bundles of muscle fibres (the detrusor muscle), in some parts presenting a trabecular arrangement, can be observed. The ureteral orifices are seen as prominent spots projecting at the posterior angles of the trigone, and by watching them, the urine can be seen to issue from them in a succession of fine streams or jets. Meyer[4] has observed that this occurs at intervals of from thirty to sixty seconds.

By practice with the cystoscope, any variation from the healthy appearance of the interior of the bladder can be detected. In skilled hands the instrument is a highly valuable means of diagnosis. By its aid may be discerned morbid states of the vesical wall—cystitis, chronic cystitis, hemorrhagic cystitis, tubercular disease of the mucous mem-

[1] Epitome of Urinary Surgery, p. 122. Bristol, 1894.
[2] Electric Illumination of the Bladder and Urethra, 2nd Edition, pp. 72–73.
[3] Loc. cit., p. 457.
[4] Loc. cit., p. 472.

brane; foreign bodies may be sought for and detected, and the presence of stone or neoplasms may likewise be determined. Enlargement of the middle or third lobe of the prostate may be discovered, and, lastly, the cystoscope may furnish material aid in the investigation of surgical renal disease. By observing the orifices of the ureters, the escape of blood or pus from one or both of them in cases of hæmaturia or pyuria of renal origin may be noted, and it may thus be ascertained which kidney is affected, or whether both are the seat of disease, and so the question of operation may sometimes be settled.

No attempt is made here to give a detailed description of the morbid conditions revealed by the cystoscope, their discussion not properly belonging to this article.

Immediate Suture of the Ruptured Urethra.

To the methods of treatment in rupture of the urethra laid down by Duplay,[1] should be added that of immediate approximation of the ends of the torn canal by means of sutures, to secure rapid union. There have been a number of contributions to the literature of this subject of late years, and it may now be claimed that in suitable cases the method is an improvement over the older one of permitting the tear of the urethra to be repaired by the process of granulation.

Among those who have reported successes with this operation are Érasme,[2] Cauchois,[3] Thiriar,[4] Woolcombe,[5] Barling (four cases),[6] and Gould (two cases).[7] Érasme quotes experiments of Kaufmann, of Zurich, in suturing intentionally made, complete, transverse divisions of the urethra in dogs, by which it was demonstrated that primary union could be obtained.

The operation of suturing the urethra is performed thus: The perineum having been opened, the incision carefully deepened, all clots turned out, and the ends of the divided urethra found, a catheter is passed into the bladder from the meatus, and, with this in place, several fine catgut sutures, not including the mucous membrane, are inserted. The number of these sutures should be, in cases of complete rupture, four—one for the roof, one for the floor, and one for either side of the canal. In cases where the entire circumference of the canal is not involved in the laceration, fewer stitches will be necessary. The sutures are next to be tied, and approximation of the tear accomplished. The perineal wound being then thoroughly cleansed, its fore part should be approximated with deep sutures of silk-worm gut or wire, the posterior or most dependent part being left open, as Barling recommends, for drainage in case of leakage of urine, or of subsequent suppuration, which may of course take place as the result of extravasation previous to the operation. In Gould's and Woolcombe's cases no provision for drainage of the perineal tissues was made, the wound being closed entirely. While the results in these cases were excellent, it would seem safer, especially in cases in which the tissues have suffered

[1] Vol. VI., pp 328-329 *supra*.
[2] Annales d. Mal. d. Org. Génito-Urin., Mars, 1888.
[3] Ibid., 1888, p. 682.
[4] Clinique Brux., 1888, t. ii., p. 801.
[5] Lancet, 1888, vol. ii., p. 913.
[6] Birmingham Med. Review, 1891, p. 321.
[7] Med. Press and Circ., 1894, p. 633.

contusion to any considerable degree, to leave the lower part of the wound without sutures, and perhaps to insert a small drain. The catheter should be left in the bladder for from five to ten days, and should afterward be passed at intervals, so as to maintain the calibre of the urethra. If, after first removing it, any difficulty should be encountered on attempting to reinsert it, it would be safer, provided the patient could urinate without it, to defer further efforts to pass it until the urethral wound should be firmly healed, since the process of union might be interfered with by the end of the catheter becoming engaged and tearing apart the united edges.

Barling recommends suprapubic drainage of the bladder for ten days, instead of allowing a catheter to remain in the urethra, withdrawing the latter after the first stage of the operation, when the urethral sutures are tied. He advises that no attempt at catheterization shall be made for three weeks, if the progress be favorable.

It would seem that the suprapubic opening of the bladder, in cases where it is not rendered necessary as a step in retrograde catheterization in order to find the proximal end of the urethra, which search in the perineal wound has failed to discover, would add a complication to the operation which might well be avoided. Proof of its being unnecessary, except when this difficulty is encountered, is furnished by the favorable progress of cases in which it has not been resorted to, drainage of the bladder being carried on by the catheter left in the urethra.

In all the cases above alluded to union of the parts took place rapidly. The advantages claimed for immediate suture of the urethra for rupture are that it shortens the period of convalescence and diminishes the liability to subsequent stricture, as compared with the method of treatment which permits repair of the injury to take place by granulation.

STRICTURE OF THE URETHRA.

EXPLORATION OF THE URETHRA.—For determining the presence of stricture, as well as for ascertaining the degree to which the urethral calibre is encroached upon, the most accurate instrument, as far as the anterior portion of the canal is concerned, is the urethrometer of Dr. F. N. Otis.[1] As described by its inventor, this ingenious instrument consists of a small straight canula "terminating in a series of short movable arms, hinged upon the canula and upon each other. At the distal extremity where they unite, a fine rod, running through the canula, is inserted. This rod (which is worked by a stationary screw at the handle of the instrument) when retracted expands the ends into a bulb-like shape." A thin rubber cover fits over the movable arms, and protects the urethra from damage. An index upon the handle tells the degree of expansion of the bulb. In the instrument as ordinarily made, the bulb, when closed, is of 14 calibre F. and can be expanded as high as 40 calibre. A scale in inches is usually marked on the shaft to enable the surgeon to note the distance from the meatus of any strictures that may be detected.

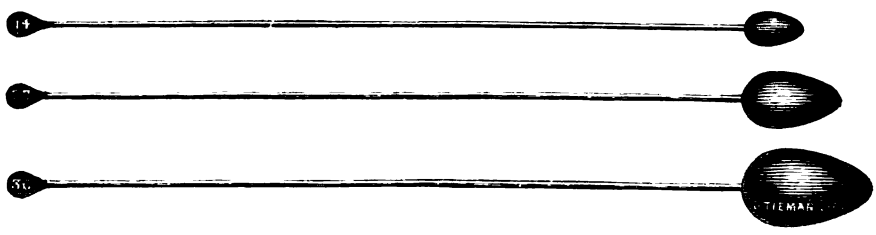
[1] Stricture of the Male Urethra, p. 77. New York, 1882. See also Vol. VI., Fig. 1419 *supra*.

In using the instrument, a fresh rubber cover should first be neatly put on, and dipped in whatever lubricant is used. The instrument is then to be inserted until its extremity is at the posterior end of the bulbous urethra. The screw is now turned, and the bulb is expanded until the patient, upon interrogation, says that he feels a sensation of slight distention. The instrument should next be moved slightly, and if it seems to be firmly held, the screw should be reversed and the size of the bulb reduced a little. The calibre should then be read off on the index. Next the instrument is to be gently and slowly withdrawn, and any points of obstruction noted, together with the calibre to which the bulb must be reduced in order to pass them.

The advantages of this instrument are, that with it several strictures of different calibre can be measured at a single introduction, and that it can be inserted through a meatus of disproportionately small size as compared with the capacity of the urethra.

The Metallic Bulbous Explorer.—This consists simply of a bulb, acorn-shaped like that of the *bougie-à-boule*, mounted upon a slender shaft, at the other end of which is a small disk upon which is marked the number or size of the bulb. It has the advantage over the rubber instrument that it can be more certainly sterilized, since it can be

Fig. 1757.



Otis's Metallic Bulbous Explorer.

repeatedly boiled without injury. It is in this respect a far cleaner and safer instrument. A good set of these explorers should range from No. 14 to No. 38 or 40 F. (Fig. 1757.)

Calibre of the Urethra.—In order to appreciate the degree to which a stricture encroaches upon the calibre of a given urethra, as well as to form an intelligent idea as to the extent to which the narrowed part must be dilated or otherwise dealt with to restore it to the normal size of the canal, it must be borne in mind that the calibre of the urethra varies in different individuals. Otis, after a large experience, has determined that the normal calibre, or the limit to which the urethra can be distended with ease, bears a certain relation to the circumference of the flaccid penis, and has adopted the following scale[1]: In a penis the circumference of which is 3 inches, the calibre of the urethra would be 30; circumference $3\frac{1}{4}$ in., cal. 32; circumference $3\frac{1}{2}$ in., cal. 34; $3\frac{3}{4}$ in., cal. 36; 4 in., cal. 38; $4\frac{1}{4}$ to 4 $\frac{1}{2}$ in.; cal. 40. Dr. J. William White[2] has adopted a scale of relation in these measurements somewhat lower than Otis's. For a penis of 3 inches in circumference, he places the urethral calibre at from 26 to 28; for one of $3\frac{1}{4}$ in. circumference,

[1] Op. cit., p. 187. [2] University Med. Mag., March, 1891, p. 295.

cal. 28 to 30; 3½ in., 30 to 32; 3¾ in., 32 to 34; and 4 in., 34 to 36, "beyond which size," he says "it is seldom necessary to go." In practice it will be found that there are cases in which the calibre of the urethra does not exactly correspond to either of these scales, the one being too large and the other too small. Again, there are occasional instances in which the urethra is abnormally small, its calibre in the healthy state being far below the average standard. Such discrepancies will be appreciated and allowed for by the experienced surgeon. In spite of these possible variations, however, it is most convenient and necessary to have a standard to guide us in ascertaining the capacity of the urethra.

Exploration of the canal should in every case be preceded by a measurement of the penis at a point about one inch posterior to the glans, and from the result of this measurement we may know what sized instrument the urethra, if free from stricture, will accommodate. If, as is often the case, the meatus be too small to admit an explorer of the proper size, it should be enlarged by careful division with a probe-pointed tenotome, cutting toward the floor. The urethrometer may be inserted without division of the meatus in nearly all cases, a distinct advantage in favor of this instrument as compared with either form of bulbous explorer.

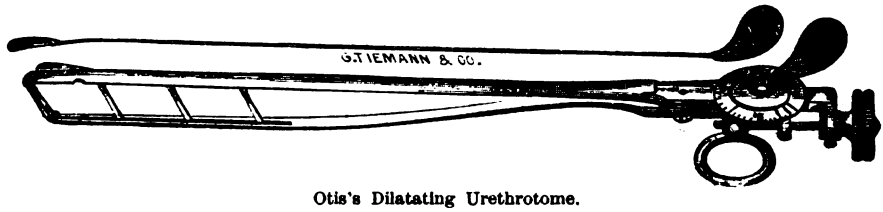
THE URETHROSCOPE IN THE DIAGNOSIS AND TREATMENT OF STRICTURE.—The urethroscope may occasionally prove of some use in the diagnosis of stricture. Strictures of large calibre are easily recognized as areas in which the mucous membrane is infiltrated or thickened, and paler in color than normal. On slowly withdrawing the urethroscopic tube, it will be observed that the mucous membrane at the affected spot folds in unevenly at the end of the tube, slowly at first, and then with a sudden start or jerk. The lumen of the canal at the infiltrated spot is more or less distorted. In the confirmed indurated stricture, the urethroscope reveals one or more spots of marked thickening, whitish or yellowish in color, and the urethral funnel or cone is irregular or absent. The peculiar flop with which these strictures fall in at the end of the receding tube is striking and easily remembered. In strictures of small calibre the urethroscope may be of service in discovering the lumen of the canal, which is often, in such cases, eccentric. When efforts to pass a small instrument through such a stricture have failed, it may be that search with the urethroscope will show where the orifice is, and so, with the aid of sight, an instrument may be successfully inserted. In cases, too, in which a false passage has been made, and where difficulty is encountered in the use of instruments in consequence of their becoming engaged in the accidental opening, illumination and visual inspection may, again, succeed in discovering the narrowed lumen of the canal.

INTERNAL URETHROTOMY.—Under this heading should be mentioned, in addition to the instruments named by Duplay for the performance of the operation, the dilating urethrotome of Dr. F. N. Otis. (Fig. 1758.)

This convenient and accurate instrument is capable of dilating the stricture at the same time that it is cut, keeping it therefore tense, and insuring its thorough division. The instrument is composed of a pair

of steel shafts connected together, as explained by Otis [1] in his description of it, "by short pivotal bars on the plan of the ordinary parallel ruler." A screw upon the handle opens or closes these, and at the same time operates an indicator telling the degree of separation of the bars in the French scale. The small knife of the instrument, which is but 2 mm. in width, is mounted upon the end of a slender steel shaft, which traverses a groove in the upper bar. When home, the little

Fig. 1758.



Otis's Dilatating Urethrotome.

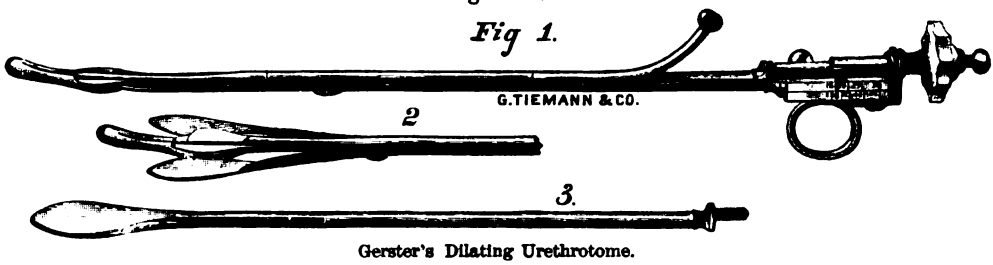
blade is concealed in a depression at the end of the groove. On one side of the upper bar is a scale upon which can be read the distance from the meatus at which the incision, on projecting the knife, will be made.

The stricture is cut from behind forward, traction upon the handle drawing the blade from the deepened end of the groove a little distance forward, when it is made to project by an elevation in the floor of the groove. Division of the stricture having been accomplished, the knife is again pushed home, and the blades are separated to the necessary extent. If the stricture offers no resistance to this, the instrument is withdrawn from the urethra.

The calibre of the Otis urethrotome when closed is 15 F., and it can be expanded to No. 45.

Another modern urethrotome deserving of notice is that of Gerster.[1] It is called by its inventor a "self-registering aseptic dilating ure-

Fig. 1759.



Gerster's Dilating Urethrotome.

throtome." The instrument is made of five parts, which can be easily detached—three steel rods (one of which carries the knife) and two screws, a thumb-screw, serving to separate the dilating rods, and a check screw securing the correct adjustment of the thumb-screw, and representing the proximal end of the urethrotome. The instrument is, when closed, of the same calibre (15 F.) as the better known one of Otis, and like it can be expanded to calibre 45. The main advantage in favor of Gerster's instrument is that it can be taken apart without difficulty and cleansed with certainty. (Fig. 1759.)

[1] Op. cit. [2] New York Med. Journ., 1889, vol. xlix., p. 683.

The operation of dilating internal urethrotomy is one requiring nicety and precision of work. It should be limited to strictures occurring not deeper than the fore part of the bulb of the urethra. The patient should receive both general and local preparation for the operation, and antiseptic precautions should be followed out, as will be detailed in the section on Urinary Fever. The procedure is usually not so painful as to require general anæsthesia, this being necessary only when several dense, unyielding strictures are to be cut, or in cases of extremely nervous individuals. Ordinarily cocaine anæsthesia will suffice. A small amount of a four-per-cent. or five-per-cent. solution may be injected into the urethra as far as the seat of stricture, or may be conveniently applied by means of an applicator through a urethral tube introduced down to the same point.

The stricture being cut, and its thorough division assured by the easy passage and withdrawal of the expanded urethrometer, or of a bulbous explorer of the ascertained normal calibre of the urethra, a full-sized sound should be passed, and afterward the urethra should be irrigated with boric-acid solution, a soft-rubber catheter should be inserted, and the bladder should be evacuated and then washed out with the same solution. The catheter may be left in the bladder for twenty-four hours subsequently.

A practical hint of some value is not to expand the urethrotome to the full capacity of the urethra before division of the stricture. If this be done, the incision may extend into the peri-urethral tissues, and give rise to troublesome hemorrhage. The incision should be made, as a rule, in the roof of the canal, and with the instrument expanded to a size 2 or 3 mm. less than the normal calibre of the urethra. An annoying sequel of the operation occasionally, though fortunately rarely, met with—viz., incurvation of the penis—may also be avoided by observing this suggestion. All that is intended by the operation is to completely divide the tissues of the stricture itself, and the cut should be no deeper than necessary to accomplish this.

The patient should be confined to his bed or his room for a few days, after which he may with care resume his daily avocations. At the same time, the passage of the full-sized sound should be begun, and repeated every third or fourth day, and afterward at longer intervals, until its use can be finally abandoned.

Performed with the precautions above indicated, and limiting the operation to strictures occurring in the first five or five and a half inches of the urethra, the amount of risk attending it, in a healthy individual, is very slight, in fact almost insignificant. Otis says[1] "I am able to state with confidence that complete division of all strictures anterior to the bulbous urethra (*i.e.*, from five to six inches), by dilating internal urethrotomy properly performed, is one of the simplest and safest of all surgical operations."

SUTURE OF THE URETHRA AFTER EXTERNAL URETHROTOMY.—This proceeding has been employed with success in several cases reported by A. Marmaduke Shield[2] and A. P. Gould.[3]

The steps of the operation as described by Shield are: After careful

[1] Loc. cit., p. 278.
[2] Lancet, 1888, vol. ii., p. 760.
[3] Med. Press and Circ., London, 1894, p. 633.

exposure of the urethra and division of the stricture with a fine, sharp knife, so as not to push the fibrous tissues ahead of it, a large gum catheter is inserted into the bladder, and a series of fine catgut sutures are inserted through the margins of the cut urethra, and then carefully tied. The soft parts covering the urethra, except the posterior one-third of the wound, which is left open for drainage, are united by deep wire sutures. The catheter is left in the bladder for one week, and then taken out, cleansed, and reinserted, being worn for about a month. The bladder is washed out daily with warm boric-acid solution. The perineal sutures are removed at the end of two weeks.

Shield reports three cases, in all of which healing was prompt and complete, and Gould four cases which also did well.

In view of these successes, as well as of those obtained in suture of ruptured urethra, it may be said that this method may be adopted with a prospect of rapid healing of the urethra in cases in which fibrous thickening about the point of stricture is not marked, or where the stricture is of limited extent.

SUPRAPUBIC CYSTOTOMY AND RETROGRADE CATHETERIZATION.—This operation, briefly mentioned by Duplay, has in recent years occasionally been resorted to with success in cases of impermeable stricture, in which it has proved impossible to find the urethra by the external perineal operation. Cases in which it has been successfully performed have been recorded by Howse,[1] Dixon,[2] Troisfoulaines,[3] and Vigo.[4]

The operation is legitimate in any case of stricture in which, as the result of traumatism, or of inflammatory deposits about the canal, the anatomy of the parts is so altered as to render it impossible to trace or to recognize the urethra; or in cases of rupture of the urethra in which careful search fails to discover the proximal end of the canal. Instances will, however, be rare in which either by the operation of Wheelhouse or by that of Cock, the attempt to establish the continuity of the urethra will fail.

COMBINED INTERNAL AND EXTERNAL URETHROTOMY.—This operation, which has for its object drainage of the bladder through the perineum, in order to prevent contact of the urine with strictures divided by the internal incision, has, under certain circumstances, much to commend it. Mr. Reginald Harrison,[5] to whom the profession is indebted for bringing it into notice, points out, as the advantages to be gained by it, that it not only tends to improve the condition of the divided stricture by relieving it from the irritating effect of urine flowing over it, and from the consequent inordinate exudation of plastic lymph thrown out at the seat of incision, but that it prevents the occurrence of urinary fever resulting from urine becoming pent up in the wounded tissues.

The irritating effect upon a wounded surface of the passage of urine without free drainage, and the excessive inflammatory deposit resulting

[1] Trans. Clin. Soc., London, 1878, vol. xii., p. 9.
[2] Amer. Pract. and News, Louisville, 1887, N. S. vol. iii., p. 392.
[3] Ann. de la Soc. Méd.-Chir. de Liège, Mars, 1888.
[4] Ann. d. Mal. d. Org. Génito-Urin., Juin, 1888, p. 436.
[5] British Med. Journ., July 18, 1885. Lectures on the Surgical Disorders of the Urinary Organs. Fourth ed. London, 1893.

therefrom, is well exemplified in the cases of severe traumatic stricture met with in practice, where great masses of lymph, extensively involving the peri-urethral tissues, indicate the seat of lesion.

In the pendulous urethra, as well as in the bulbous and membranous portions, strictures are often met with of the indurated or nodular variety, in which attempts to relieve by dilatation are followed by swelling, inflammation, and afterward by recontraction. While such cases are obviously suited for internal urethrotomy, it is found that this operation alone will not secure the absorption of the indurated tissue. Mr. C. W. Mansell Moullin,[1] in discussing the permanent cure of stricture by external urethrotomy, points out as the essential conditions removal of the original irritant, and the maintenance of complete physiological rest of the part. This can be accomplished in strictures dealt with by internal urethrotomy by adopting the operation suggested by Harrison—the combination of "perineal puncture," as he terms it, with the internal cutting.

The operation is described by Harrison[2] as follows: "The patient having been anæsthetized, an internal urethrotomy is performed. He is then placed in the lithotomy position, when a perineal puncture is made on a full-sized median grooved staff, and a drainage-tube is passed into the bladder. As the anterior portion of the urethra will be unused as long as the drainage continues, I usually introduce a piece of thin drainage-tube by the meatus, and bring it out through the wound by the side of the perineal tube, and then make a loop of it. In this way this portion of the urethra can be washed out and the internal urethrotomy wound kept clean and sweet; unless this precaution is taken, a blood clot may be retained in the anterior urethra, and, by decomposition, cause a rise in temperature. It is therefore not surprising that the cicatricial splice thus introduced into the canal materially differs from one that would be formed under opposite conditions."

The operation is indicated in all strictures of the nodular or contractile variety occurring in the anterior urethra, particularly in the bulbous portion deeper than its anterior limit, in cicatricial strictures, and in those accompanied by fistula.

RESECTION OF THE URETHRA (URETHRECTOMY).—This mode of operative treatment may be available in cases of dense, impermeable, or non-dilatable strictures, with or without fistulæ, such as usually result from traumatism. A number of communications to literature on this subject have been made, showing good results. The steps of the operation are well illustrated in the report of two successful cases by T. H. Manley.[3] In the first case the urethrectomy was complete.

With a filiform guide in the urethra he cut down upon and divided the stricture, which was then excised *en bloc*. Next, with a sound introduced, the ends of the severed canal were approximated by a circular seam of catgut, the cellular and muscular layers only being included in the stitches. The peri-urethral tissues were then brought together by a line of catgut sutures. No drainage was used. The patient made a perfect recovery. In the second case the resection was partial, a narrow stricture involving only the floor of the urethra

[1] Lancet, 1891, vol. ii., p. 652.
[2] Lectures, p. 108.
[3] Annals of Surgery, Feb., 1893, p. 181.

being excised. The gap here made was closed by suture of the peri-urethral tissues. The result in this case was also good.

Vignard,[1] reviewing fifteen cases of complete excision, finds that the ends of the resected urethra can usually be well approximated by suture. He regards the operation as the best plan of treatment for traumatic strictures, affording radical cure, temporary benefit being all that can be expected from other methods. Not only is it especially indicated in impassable strictures of this variety, but also in well-defined, unyielding strictures, though permeable. The soft parts should be accurately united, and drainage is not necessary in most cases. A catheter should be left in the bladder for six days.

Manley considers that resection and restoration of the continuity of the urethra are indicated in cases of rebellious perineal fistulæ, whether due to injury or to gonorrhœa, and in strictures unsuited for internal urethrotomy, in which, after opening the urethra by external urethrotomy, the occasion should be taken to "hew a gutter through the cicatricial tissues," and to form a new floor for the canal from the surrounding parts. He also considers urethrorrhaphy indicated in all cases of rupture of the urethra, the operation being done as promptly as possible.

Resection of the urethra is discussed in a lecture by Guyon,[2] who reports nine cases of impassable stricture, two of them complicated by fistulæ, in which removal of the contracted mass and suture was followed by prompt healing. He says that from all sources sixty-four cases, forty-nine complete resections and fifteen partial, have been collected by one of his internes, M. Roqués.

URETHROPLASTY.—In cases of defect of the urethra, or loss of substance due to sloughing, or in those of stricture requiring extensive resection, in which a space is left too wide to permit of approximation and suture of the ends of the urethra, a plastic operation may be resorted to in order to fill the gap. This may be done either by cutaneous flaps (autoplasty), or by transplantation of mucous membrane, as illustrated by the following cases:—

(1) *Cutaneous Flaps.*—Delorme[3] describes a case of dense stricture in which he excised the membranous and part of the prostatic portion of the urethra, and to close the gap so left made a rectangular flap 1 cm. in front of the anus, 8 to 9 cm. in breadth and 4 cm. long, its base being on the right side of the perineum, one finger's breadth from the median line. The extremity of the flap was folded double to the extent of 3 cm. by joining the epidermal surfaces by three catgut sutures on each side of the doubled portion, making the flap resemble a glove finger. The doubled flap was then securely fixed into the gap in the urethra by an arch of silver wire sutures passed from the surface through the depth of the urethra, from its anterior to its posterior border, and by lateral sutures. The skin surfaces were sutured with silkworm gut, and a gum catheter was inserted and left in for several days. The result of the operation was good.

In two cases of perineo-scrotal defect of the floor of the urethra, nearly two inches long, resulting from sloughing following extravasa-

[1] Jour. Cutaneous and Genito-Urinary Dis., New York, June, 1893, p. 241.
[2] Gaz. Hebdom., 14 Mai, 1892.
[3] Gazette des Hôp. de Paris, 1889, t. lxii., p. 619.

tion, Parker[1] adopted the skin-flap method with satisfactory results. He raised a flap on both sides of the gap. That on the left side was nearly one inch wide, and that on the right was barely one-eighth of an inch. The large flap was turned over with its epidermal surface inward, and sutured with many catgut sutures to the edge of the smaller flap, completing the urethral tube along the whole defect. The skin of the scrotum was then dissected up all around the resulting wound, and was used to cover in the raw surface of the reflected flap and the place from which it was raised.

(2) *Transplantation of Mucous Membrane.*—E. L. Keyes,[2] of New York, in a case of extensive dense stricture, with fistulæ, resorted to the method suggested by Mensel—transplantation of the inner layer of the prepuce. The stricture, which extended from in front of the bulb to well back under the symphysis pubis, was excised, together with all morbid tissues and fistulous tracts. To fill in the large deficiency left in the urethra, he transplanted a piece of the inner layer of the carefully sterilized prepuce measuring one and a half by two inches. This was sutured into the gap by four catgut sutures anteriorly, and at several lateral points. No sutures were placed posteriorly, because it was impossible to reach the prostatic end of the urethra. The bladder was drained by a tube passed from the perineum, and, in order to effect coaptation of the flap by rounded pressure, he placed in the anterior urethra a drainage-tube, bringing its end against the bladder drain. The case did well. One year later a No. 21 sound could be passed. The point of union of the graft with the healthy urethra could be detected as a fibrous, strictured ring.

TREATMENT OF STRICTURE OF THE URETHRA BY ELECTROLYSIS.—The application of electrolytic action in the treatment of stricture, the current bring directly applied by means of a bulbous electrode passed into the strictured area, was first advocated by Newman, twenty years ago, and has since invited the attention of a number of clinical investigators. The contributed results of experience with the method have, however, been markedly contradictory.

The advantages claimed for it are probably best set forth in one of his later contributions by Newman[3] himself, who asserts that the results are not due to dilatation with the electrode, but to a galvano-chemical absorption of the stricture tissue; that the treatment is applicable to all strictures in any part of the urethra; that he has often succeeded by it in passing strictures in which failure had resulted from other surgical treatment; that it is free from pain and inconvenience, as well as from danger; that it gives immediate relief, and that no relapse takes place.[4] The causes of failure with the method he attributes to, first, lack of skill on the part of the operator as to both use of the instruments and management of the electric current; secondly to mistaken diagnosis; and thirdly, to faulty instruments.

In England the method was carefully taken up by Steavenson and W. B. Clarke, who obtained results substantiating Newman's claims.[5]

[1] Liverpool Med.-Chir. Journ., 1888, vol. viii., p. 515.
[2] Journ. Cutaneous and Genito-Urin. Dis., 1891, vol. ix., p. 401.
[3] Brit. Med. Journ., 1887, vol. ii., p. 172.
[4] Trans. New York State Med. Assoc. (1885), 1886, vol. ii., p. 415.
[5] Proc. Royal Med.-Chir. Soc. London, 1885–86, n. s., vol. ii. Practitioner, 1886, vol. xxxvii., p. 186.

F. S. Edwards,[1] after testing the treatment, attributes to it these advantages, viz.: confinement of the patient is not necessary; there is no risk to life, no pain, only sometimes slight discomfort, and no bleeding; if unsuccessful, it does not interfere with urethrotomy being undertaken forthwith; and a permanent cure may follow, which is the rarest thing by any other method. He says that electrolysis is "of the greatest use in strictures of small calibre to facilitate the passage of a urethrotome, and in impassable strictures to render possible the passage of bougies, if for any reason electrolysis is not persisted in." When the stricture is recent, and approaches the ring variety, "the better," he says, "the result." Strictures of the deep urethra, not amenable to treatment by dilatation, should, he thinks, be subjected to electrolysis before any cutting operation is thought of.

On the other hand, results have been published which do not support the method. Thus, following its employment, increase in the stricture from swelling, urethral irritation followed by discharge, difficult micturition, or, immediately after the sitting, chill and fever, have been observed. Cases in which such results were noted have been reported by G. W. Allen.[2]

F. Tilden Brown,[3] in an excellent discussion of the subject of electrolysis, reasons from the known action of electricity when employed for the cure of nævi, or for the obliteration of hair follicles, and says that "shrinkage does not take place in a peripheral accumulation at the expense of a central attenuation, but just the reverse. Hence any gain in the calibre of an organic stricture following such treatment is due to dilatation by the instrument, and in direct opposition to the contracting influence of electrolysis." He names as the only advantages which he has found the method to possess: that it encourages patience and gentleness; that it furnishes two aids in overcoming spasmodic stricture, (*a*) lubrication of the canal, and (*b*) anæsthetizing influence upon the terminal nerves at the irritable point, and possibly earlier relaxation of spasm by muscular exhaustion following overdistention; and that it is followed by a slightly increased rate of exfoliation of hypertrophied epithelial masses.

E. L. Keyes, as the result of his experience with the method, in carefully observed cases, makes this statement:[4] "My study of the subject, and the experience it has brought me, digested with all the impartiality I possess, lead me to state that the allegation that electricity, however employed, is able to remove organic stricture *radically*, lacks the requirement of demonstration."

Desnos,[5] more recently, in an article detailing the results of experimental researches upon the urethræ of dogs, as well as the effects following the clinical application of electrolysis in forty-six cases, records an experience far from encouraging to the advocates of the method.

Without going further into detail on this subject, it may be said that the claims advanced for electrolysis have not been substantiated by a generally favorable experience. It is good proof of this that, in the two decades which have passed since its introduction, the method has gained no appreciable foothold in practice.

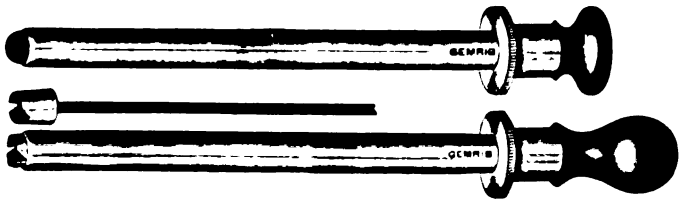
[1] Med. Press and Circ., 1888, n. s., vol. xlv., p. 369.
[2] Boston Med. and Surg. Journ., 1887, vol. cxvii., p. 621.
[3] Journ. Cutaneous and Genito-Urin. Dis., New York, 1888, vol. vi., pp. 244, 294.
[4] New York Med. Journ., Oct. 6, 1888.
[5] Journ. des Mal. des Org. Génito-Urinaires, Août, 1893.

URETHRAL NEOPLASMS.

To the literature of urethral neoplasms a number of additions have been made in the way of reported cases. The division of these into malignant growths, vegetations, and polypi, is confirmed by these records. Very considerable advance in the diagnosis and treatment of these cases has resulted from the use of the urethroscope. With this instrument a careful study of the urethra will disclose the location and nature of any neoplasm that may be present. The most easily discovered are the vegetations, which, though sometimes found in groups in the deeper portions of the canal, grow most often in its extreme anterior part, in the region of the fossa navicularis or even closer to the meatus, and are quite similar to the papillomata occurring on the surface of the prepuce and glans. As seen with the urethroscope, they are usually light in color and present an irregular shape, and with a probe their soft structure may be noted. The polypi, which are generally seated in the posterior portions of the canal, are seen as bluish masses of rounded outline, and are recognized as they suddenly jump into the field at the end of the tube. It is sometimes difficult to expose them to view in order to discern their point of origin, but this can be accomplished by carefully changing the position of the tube. Not only is the diagnosis of urethral growths easily established by the urethroscope, but their accurate removal with forceps or curette is thus rendered possible.

A curette to be used in conjunction with the urethroscope has recently been devised by Dr. J. B. Deaver.[1] (Fig. 1760). He calls it a

Fig. 1760.



Deaver's Circular Urethral Curette.

"circular cutting curette." It consists of a circular blade with two notches which will engage and detach the vegetations. It is mounted on a rod, the handle of which fits closely the proximal end of the urethral tube, and thus it is steadied during manipulation.

A very able account of a number of cases of urethral neoplasm studied with the endoscope has lately been published by Klotz,[2] of New York.

An operation which has occasionally been resorted to for the removal of urethral neoplasms, to which Duplay applies the ancient terms of caruncles or carnosities, consists in opening the urethra in its roof through an external incision, then removing the growth, and closing the wound by hare-lip pins. It is, of course, only applicable in the

[1] Medical News, 1894, vol. lxv., p. 98.
[2] New York Med. Journ., Jan. 26, 1895, p. 99.

penile urethra, where, by dissecting apart the corpora cavernosa, the roof of the canal may be reached. Two cases in which this operation was resorted to are reported by R. H. Harte.[1]

Urinary Fever—Pathogenesis and Treatment.

Pathogenesis of Urinary Fever.—In recent years the pathology of urinary fever has been the subject of considerable investigation, the results of which have tended with singular uniformity to place the affection in the class of septic intoxications. In the light now thrown on the subject it seems that Velpeau, who, as Duplay remarks, attempted to explain certain urinary accidents on the ground that they were caused "by the re-entrance into the current of the circulation of some of the constituents of the urine," was working in the direction of modern investigation. Maisonneuve, Sédillot, and Reliquet also followed in the same general line indicated by Velpeau, in their theory of the relationship between direct urinary absorption and urinary fever.

Clinical studies made by Mr. Reginald Harrison[2] on the occurrence of urinary fever after the operation of internal urethrotomy, lead him to conclude that the phenomenon is to be attributed to the absorption of urine pent up in the wounded tissues. He found that the fever could be prevented in these cases by combining perineal drainage of the bladder with the internal division of the stricture, access of urine to the wounded tissue being so precluded. From his observations[3] he reached the belief "that the urine could provide septic material necessary for the production of urinary fever." From the experimental standpoint much work has been done which establishes the relation of the urine itself to the evolution of an attack of urinary fever. Bouchard, to whose elaborate investigations Harrison alludes, has found that there exist, even in normal urine, alkaloids, absorbed from the intestinal tract, which render it toxic. Experimenting upon rabbits, he injected normal urine into a vein, and found that it produced a toxic condition manifested by contraction of the pupils, frequent and hurried respiration, reduction of temperature, diminished and finally abolished reflexes, and death, preceded by convulsions and coma. He calculates that a man excretes in two days and four hours enough of the toxic elements to cause his own death. He found that the action of the alkaloid secreted during the hours of sleep was convulsive in its effects, while that eliminated during the day was narcotic.

Investigations of urine made from another standpoint—that of bacteriology—have furnished much useful knowledge bearing on the pathogenesis of urinary fever, and explain much that is inexplicable on any other grounds. Albarran and Hallé[4] have discovered a bacterium, which they named the Bacterium pyogenes, that was present in forty-seven out of fifty specimens of pathological urine from patients suffering from stricture, prostatitis, cystitis, and pyelo-nephritis. In many of these it was the only micro-organism present. In a number of experiments upon mice, guinea-pigs, and rabbits, they produced cystitis,

[1] Univ. Med. Mag., 1889, vol. i., p. 509. [2] British Med. Journ., July 18, 1885.
[3] Lectures on the Surgical Disorders of the Urinary Organs, 4th edition, p. 68.
[4] Bulletin de l'Acad. de Méd., 1888, t. xx., p. 310.

pyelo-nephritis, etc., with pure cultures of this bacterium. It has been found in the blood, and in other organs than those of the genito-urinary system, but it seems especially active in the latter. From their observations and experiments, they conclude that this bacterium is pyogenically an infective organism; that it is always (frequently the only micro-organism) present in purulent urine; and that it produces suppurative inflammation of the genito-urinary tract. It has also caused diverse renal lesions, and when present in the blood produces rigors, general infection, etc.

A number of investigators, including Achard and Renault,[1] Rodet,[2] Krogius,[3] and Reblaud,[4] have detected the presence of a bacillus in the urine capable of producing general infection, and have found that the Bacterium pyogenes of Albarran and Hallé is identical with the Bacillus coli communis.

Achard and Renault have conducted a series of experiments establishing this identity, and remark that it is but just to recognize that at the time when the Bacterium pyogenes was studied, the Bacillus coli communis was scarcely considered as a microbe possessed with virulent properties.

Rodet reports with Professor Renault a striking case, the previous history of which included a light attack of gonorrhœa and an attack of epidemic influenza. Pus was present in the urine in considerable quantities, and upon examination it was found to come from the kidney. Lumbar nephrectomy was done, and the kidney removed was found to be riddled with large abscesses, and to contain three large calculi. Three animals were inoculated with fragments of the renal substance, two guinea-pigs subcutaneously, and one rabbit by intravenous injection. The animals died, and cultures from the organs and fluids isolated the Bacillus coli communis, which Rodet believes to be the bacterium described by Albarran and Hallé under the name of Bacterium pyogenes.

Reblaud, studying in the service of Professor Guyon the pathogeny of cystitis in women and of urinary infection in general, was struck from the beginning by the analogy between the micro-organism met with in infected urine, and studied by Clado, Albarran and Hallé, and the Bacillus coli communis, now known to be so baneful.

Results corroborating those just given have been reported by other observers, and the evidence that infective micro-organisms may be conveyed by the urine, to a wound or abrasion of the surface of some portion of the urinary tract, must be accepted as positive. It would thus appear that, finding a medium suitable for their propagation and the development of their virulence in the wounded tissue, these micro-organisms, or their products, are capable of causing systemic infection, or urinary fever, which, as we have seen, does not occur when contact of the urine with the wounded surface is precluded by drainage.

While the evidence furnished by bacteriological and chemical investigations affords strong support to the theory of the septic nature of urinary fever, it may be questioned whether the occurrence of the

[1] Comptes Rendus de la Soc. de Biologie, Paris, tome iii., 9e série, Séance du 12 Déc., 1891.
[2] Ibid., Séance du 19 Déc., 1891.
[3] Arch. de Méd. Expériment., 1e série, tome iv., 1892, p. 66.
[4] Comptes Rendus de la Soc. de Biologie, Séance du 19 Déc., 1891.

different forms of the affection may be explained on the same grounds. It may be objected to the theory of septic infection that urinary fever may be met with in cases in which no wound or injury has been inflicted upon the urethra—as, for example, in instances of simple catheterization. Such occurrences are sometimes put down as being of nervous origin—shock. Before, however, attributing them to that uncertain source, it must be definitely shown that the conditions for septic infection positively do not exist. In such a case, is it known absolutely that the urethra was not wounded or abraded in some part by the passage of the instrument? Was the catheter itself sterile? and, thirdly, was the urine of the patient free from pathogenic organisms? As to the first question, it will often be found upon endoscopic examination of the urethra, after even the gentlest passage of a sound or catheter, that a small rent or abrasion of the mucous membrane has been made, when there is no external evidence to prove it, and when the patient's own sensations also fail to disclose it. Here, then, we see, unsuspected, a point for infection to take place. Doubtless most of the cases of urinary fever of so-called nervous origin will, then, find their true explanation as being due to septic infection.

It may be that the several different types of urinary fever cannot be explained on the same grounds, but it seems reasonable, in the light of our present knowledge of bacteriology, to attribute the variation in type to differences in degree of septic infection. Doubtless, further developments in the study of bacteriological chemistry will shed light upon these as well as upon many other pathological problems.

TREATMENT OF URINARY FEVER.—The demonstration of the septic nature of urinary fever has led to the employment of antiseptic measures in its treatment, especially in the direction of prevention. These preventive measures include the local and general preparation of the patient, as well as the careful sterilization of all instruments used in an operation on the genito-urinary tract, however trifling it may be.

First, as to the general preparation of the patient. Whenever it is possible, that is, when the time can be afforded, he should, before being submitted to any operation, especially in cases of prolonged vesical or urethral disease, be compelled to rest in bed for two or three days previously. The condition of the alimentary tract should be carefully regulated by the administration of a purge, preferably a mercurial followed by a saline. After this he should be placed upon treatment with a drug capable of exercising an antiseptic effect upon the urine. For this purpose boric acid, first suggested by Dr. E. R. Palmer,[1] has given very satisfactory results. It should be given in powder or capsule, in ten-grain doses every three or four hours for a day or two preceding the proposed operation, and should be continued for some days afterward. This remedy may be administered without apprehension of its causing any irritating effects. My own experience with it, and I have used it in numerous cases, has been singularly favorable. It seldom happens that unpleasant symptoms are caused by it, but occasionally a patient may be met with upon whom it appears to exercise a depressing influence, and causes a headache of such severity as to demand the discontinunce of the drug. Another internal antiseptic which has

[1] Journ. Cutan. and Genito-Urin. Dis., 1887, vol. v., p. 404.

given satisfactory results in the sterilization of the urine, is salol. It may be given for this purpose in doses of from five to ten grains four times a day, or oftener, according to circumstances. It appears that the antiseptic properties of salol, exhibited with this intention, depend upon its elimination by the kidneys in the form of its constituents—phenol and salicylic acid. Benzoic acid is also recommended as an internal urinary antiseptic, but it is feeble in its action as compared with either of the foregoing.

The local preparation of the patient consists in thoroughly scrubbing the genitalia and the surrounding parts with soapsuds and warm water, and then with a solution of bichloride of mercury 1–2000. The urethra should be cleansed, and the bladder too, when possible, with either boric-acid solution, or the combination of boric acid and salicylic acid in solution, known as Thiersch's fluid. According to Guyon, nitrate of silver in 1–500 solution possesses definite antiseptic properties, and he recommends its use in cases of operation on the urinary organs.

Cases of chronic retention due to long-standing tight stricture, or to enlarged prostate, should be approached by the operator with great caution. Guyon[1] explains that in this condition, which he calls "incomplete retention with distention," there is produced a "state of receptivity" of the urinary organs to the invasion of microbes, and that, concomitant with distention of the bladder, ureters, renal pelves and uriniferous tubules, with urine, a congestion of the surface of these organs exists which renders them prone to septic infection. Septic matter introduced from without into the urethra or the bladder, as by a catheter or other instrument, will rapidly infect, under these circumstances, the whole urinary tract.

In patients upon whom it is proposed to perform the operation of litholapaxy, the urethra should first be carefully explored to determine whether the urethra is free from stricture, injury to which by the lithotrite or evacuating tubes, would, by providing a wounded surface through which infection could take place, add to the operation the danger of the occurrence of urinary fever. In such patients, if stricture be found to be present, it will be safer to dilate it up to the required capacity for the easy passage of the crushing and evacuating instruments, before attempting litholapaxy.

Patients using habitually a catheter upon themselves should be taught to observe antiseptic precautions in the care and employment of the instrument, and also how to wash out the bladder with a mild antiseptic fluid, such as boric-acid solution.

The preparation of instruments for use upon the genito-urinary tract demands that they should be scrupulously cleansed and subjected to thorough sterilization. Steel instruments may be rendered sterile by boiling. Those made of rubber cannot, obviously, be long subjected to this process without injury. They may be sterilized by dipping them for a moment in boiling water, and then placing them in a bichloride solution, 1–2000, or in one of carbolic acid, 1–40.

By observing strict asepsis and the preventive measures as above indicated, the occurrency of urinary fever after operations upon the genito-urinary tract will be found to be exceptional.

Curative Treatment.—If for any reason an attack should develop,

[1] La Semaine Médicale, 4 Mai, 1889.

the patient should, during the stage of chill, be warmly wrapped in blankets and surrounded with hot water-cans. Of the remedies recommended for the relief of urinary fever, those which have, perhaps, found most favor are quinine in liberal doses, and the tincture of aconite, the latter being given in two-minim doses, and its effect watched. In cases where the secretion is diminished, or even suppressed, resort may be had to the vapor bath, dry cupping of the loins, the hypodermic injection of pilocarpine, or the administration of the infusion of digitalis, as recommended by Gouley, in drachm doses every hour or two, its action on the circulation being carefully noted. Mr. Henry Morris speaks highly of hypodermic injections of atropine combined with morphine in these cases.

The internal antiseptics already named should be exhibited in conjunction with whatever remedies are used during the attack.

INJURIES AND DISEASES OF THE MALE GENITAL ORGANS.

BY

GWILYM G. DAVIS, M.D. UNIV. PENNA. AND GÖTTINGEN, M.R.C.S. ENG.

SURGEON TO THE GERMAN HOSPITAL AND TO ST. JOSEPH'S HOSPITAL, PHILADELPHIA.

INJURIES AND DISEASES OF THE PENIS.

THE most severe cases of injury to the male genital organs are those occasioned by the patient being caught in revolving machinery. Kappeler[1] has collected nine cases including two of his own. The great loss of skin in these injuries is followed by the formation of such an amount of scar tissue as to impair the functional value of the organ.

Kappeler says that if sufficient of the internal layer of the prepuce remains to allow of its attachment to the skin of the scrotum or pubes, then recovery occurs without loss of either urinary or genital functions. If, however, the skin is so deficient as to require a plastic operation in order to unite it to the prepuce, then, although the penis may perform its function, it will be dwarfed. If the membrane is entirely destroyed or absent, hard cicatrices form and act as barriers to coition. Under these circumstances transplantation of skin is apt to be both difficult and unsatisfactory, as gangrene of the flaps almost always occurs. If the scrotum is entirely gone the testicles may be drawn up under the skin of the pubes, or, if healing is delayed, they may be so bound down by cicatrices that pressure may require their removal.

In both of Kappeler's cases coition was possible, but azoöspermia existed, although there was no atrophy of the testicles.

LUXATION OF THE PENIS.—A peculiar case of scrotal luxation of the penis is recorded by Malenovsky.[2] It occurred in a married peasant thirty years of age. While busy about a thrashing machine, he was caught between a revolving horizontal bar and its straps, and thrown over, the right half of his loose and thick trousers being entangled and tightly stretched, and violently dragging along all the integument of the penis which was jammed between the garments and the thigh. When examined he had a complete circular rupture of the foreskin around the corona glandis, another laceration near the scroto-penile fold, and displacement of the penis under the scrotal skin.

[1] Deutsche Zeitschrift für Chirurgie, Dec., 1885.

[2] Khirurgitchesky Vestink, 1889, p. 697. Abstract in Annals of Surgery, vol. xi., p. 291 (from which this account is taken).

On presenting himself for treatment some time after the accident, the integuments of the penis were hanging down on the anterior surface of the scrotum in the shape of a flabby and shortened cutaneous tube. The opening was contracted and would not admit a little finger. A cicatricial opening existed at the scroto-penile fold through which the urine was passed. On erection the penis remained entirely within the scrotum. An attempt was made to replace the penis in its cutaneous tube by (*a*) a crucial enlargement of the preputial orifice; (*b*) dilatation of the tube cavity by big-sized drainage-tubes and tupelo tents; (*c*) division of a cicatricial partition which existed one and a half inches back; (*d*) dilatation of the incision; (*e*) breaking down the adhesions between the glans and the scrotum, and (*f*) attempts at dragging out the glans from its scrotal cavity into the now prepared cutaneous tube. All these, however, utterly failed, the main obstacle being formed by a dense cicatricial constriction in the upper portion of the restored canal. A plastic operation was then resorted to. Having split up the integumental tube from the preputial opening to the superior one, as well as the scrotum, the author sewed (*a*) the free preputial edge with the remnants of the foreskin on the glans, (*b*) the edges of the penile integumental incision with the scrotal flaps, and (*c*) the latter anteriorly and inferiorly with the remnants of the inner layer of the foreskin on the glans. The silk sutures used were removed on the sixth and eighth days, and the wounds healed by first intention. The member then measured two inches from the glans to the pubes, and to the patient's delight proved effective for all his purposes. The penis increased markedly in length. The author only found accounts of four other cases in the literature of the last forty years; they were those of Nélaton, Bonnain, Heyenberg, and Moldenhauser. The first two were scrotal luxations, the third was successfully reduced on the tenth day, and the last was a hypogastric luxation in a man aged fifty-seven years.

[The editor saw at the Pennsylvania Hospital, about two years ago, a remarkable case in which by traumatism the urethra had been torn across in the scrotal region, and was completely invaginated through the meatus, protruding from the end of the glans penis as a flexible tube, about the thickness of a lead-pencil and covered by mucous membrane. As reduction could not be effected, the invaginated urethra was excised, and an opening was made in the perineum to allow of urination. The patient made a good recovery.]

Fracture of the Penis.—A case of fracture of the penis came under the care of Krog,[1] in which a man supposed to be suffering from chordee had allowed a window to fall on the distorted organ. Eight days after the injury the penis was swollen to six or eight times its normal size, and of a purplish color. There was no pain, and the urine was passed with no great trouble, though slowly.

Preputial Calculi.—These not only arise from small fragments passed from the bladder and retained by a contracted preputial orifice, but they originate also *in situ*, either from retained and decomposing urine in a dilated foreskin, or from an infiltration of retained smegma by lime salts deposited from the urine. Jenkins[2] gives the case of a

[1] Medical Record, vol. xli., 1892, p. 397. [2] Annals of Surgery, 1887, vol. v., p. 211.

negro, aged thirty, who complained of pain and swelling of the penis. The foreskin was very long and from it flowed a purulent secretion. This condition had existed for several months. On operation two large concavo-convex calculi were found. There were also several ulcers of the parts. Nelson's case of thirty-eight calculi, and Brodie's of sixty calculi are also referred to. The treatment of these cases is circumcision with subsequent attention to cleanliness.

BALANO-POSTHITIS.—Balanitis, or inflammation of the glans penis, can exist alone, but is usually associated with inflammation of the prepuce likewise, whence the compound term balano-posthitis is used.

Treatment.—When simple and non-venereal in character, particularly in children with a tendency to phimosis, in whom the urine is prone to set up inflammation of the part, daily retraction of the prepuce and washing, followed by an application of boric-acid ointment, are all that will be found necessary. In the more marked cases, arising from various causes, in adults, if the glans can be uncovered, after cleansing, a powder of equal portions of boric acid, calomel, and bismuth subnitrate may be dusted on; the effort being made to keep the parts as dry as possible. If the affection is more severe, a layer of cotton dusted with the powder may be applied and the foreskin drawn over it. Lotio nigra (calomel ʒij., lime water Oi.) I have found to be a most excellent remedy; after cleansing, the glans is covered by winding absorbent cotton around it, and the black wash is dropped on until it is well soaked, when the prepuce is brought forward. This dressing may be changed several times daily. If phimosis prevents retraction of the prepuce, and it is thought undesirable to slit it up, then the parts should be cleansed as well as possible by means of a syringe, the nozzle being introduced between the glans and the foreskin. After this has been accomplished, pledgets of absorbent cotton well soaked in the black wash should be tucked in between the glans and its covering.

Under this treatment it is oftentimes surprising to see how soon the acute symptoms will subside. Astringent solutions of lead and zinc are also of service. If the glans can be exposed, any ulcerated spots present may be touched with a solution of nitrate of silver, thirty grains to the ounce.

When cotton is used as a dressing in these cases, it should be removed and replaced with a clean piece at least twice daily, and in bad cases still more often, as otherwise it becomes soaked with the discharges and continues a source of irritation.

Mr. Jacobson[1] describes a form of balano-posthitis occurring in gouty subjects; it is apt to be dryer and more obstinate in character than that ordinarily seen. He advises the use of citrine or tar ointments, or the oleates of lead and zinc, or lotions of bicarbonate of sodium in addition to the general treatment proper to a gouty condition. A persistent balano-posthitis in a person of advanced years should be treated by circumcision, as it is known that continued irritation in suitable subjects is liable to be followed by the development of malignant disease.

HERPES PROGENITALIS.—This is not the only form of herpes that affects the genital organs. They are sometimes involved in an attack

[1] Diseases of the Male Organs of Generation, p. 655.

of herpes zoster or shingles. The latter disease, however, is not apt to be mistaken for the former. It rarely if ever affects solely the glans and prepuce, and is distinguished by the accompanying pain and by the eruption involving the adjoining parts of one side.

PHIMOSIS.—It is undoubted that many symptoms, particularly of a nervous kind, and more or less obscure in character, may arise from a condition of phimosis. Bruce Smith[1] gives cases of convulsions and chorea which are said to have been cured by circumcision. Solon Chromatianos, a Greek surgeon, had the following curious case.[2] A cavalry officer, aged fifty-eight, after having had a balano-posthitis, became affected with extreme phimosis. The urine ballooned the prepuce and could only be expelled by violent efforts. He then had complete paresis of the sphincter vesicæ, and urine dribbled constantly. He also presented well-developed ataxic symptoms, as instability of movement, disturbances of sensibility of the soles of his feet, and impossibility of walking backward, while on closing his eyes, or in the dark, he would totter. Patellar reflexes were abolished and pupils fixed. The urine was normal. Circumcision was done, and a large sound was introduced with ease. In forty days he not only had normal urination but could make long marches, the patellar reflexes had reappeared, and the pupils acted normally.

The occurrence of cases such as the above has caused many physicians to resort to circumcision with great freedom, as a means of treatment for slight ailments, or to prevent the dire consequences supposed to necessarily follow a more or less marked contraction of the prepuce. That this operation has been done in too large a proportion of cases is my firm belief, and also that the evil results attributed to the condition present have been and often are overestimated. In infancy and childhood phimosis is a natural condition. How few are the cases seen in adults compared with those seen in children! Nature herself takes care of this condition, and it is only in a few instances that the surgeon's assistance is required.

Treatment.—When the prepuce is long and contracted, projecting far beyond the glans and becoming constantly inflamed, then it may be shortened or the orifice may be dilated. In infancy, particularly, it will oftentimes be sufficient to dilate the orifice with a pair of forceps, loosen the adherent prepuce from the glans by means of the flat end of a probe, retract the skin, cleanse the parts, and anoint them with boric-acid ointment. The prepuce is then again drawn forward, and the mother is instructed to repeat the application twice daily; being cautioned to be sure and draw the prepuce forward, since otherwise, as I have seen in one case, a paraphimosis may be produced which will require immediate attention.

In children, extensive operations are not required, and the removal of too much tissue, causing the glans to appear like a projecting button on the pubes, as I have seen, is to be carefully guarded against. In cases, even in infancy, in which there is quite a small opening surrounded by a firm sharp edge, the simple procedure of dilating, as described above, will not be advisable; slitting up or even a formal circumcision is preferable, as otherwise the opening will again con-

[1] Canada Lancet, 1891–92, vol. xxiv., p. 196. [2] Le Progrès Médical, No. 15, 1893.

tract. Slitting up the prepuce is according to Dr. Palmer, of Louisville, often preferable in children to circumcision. The unsightly flaps formed on either side, which are so objectionable in the adult, speedily disappear in the child.

In circumcising a child, it is an extremely bad plan to fix the forceps at the level of the corona and then slide it forward and cut off the projecting skin; it removes too much of the skin covering, and on removal of the forceps almost the whole organ will at times be found to be flayed. The following method is advised: If forceps are used, let them be placed near the anterior extremity of the head of the penis, and certainly not farther back than midway to the corona glandis. This much having been cut away, the mucous membrane beneath is to be loosened from the glans and slit up nearly but not quite to the corona, in a line parallel to which it is then to be removed on either side with scissors, and at a sufficient distance to allow just enough space for the proper insertion of the sutures. On nearing the frænum the incisions should slope forward, and the mucous membrane at this point should not be cut transversely from one side directly to the other, lest there should be difficulty in properly uniting the raw edges. A continuous suture of catgut is then inserted, beginning at the frænum on one side and being carried all around. Any bleeding points are to be controlled by being included in the suture. A little cotton and collodion constitutes the dressing, or some boric-acid ointment may be smeared on, or iodoform applied, and a pad of cotton laid over it and retained by the diaper.

In adults the procedure is much the same. Simple slitting up is not desirable, but should be completed by carefully rounding off the projecting flaps of tissue. The cases in which I have used the continuous catgut stuture have proven so much more satisfactory than those in which the interrupted suture has been used, that I prefer it in most instances. Care should be taken to avoid a bare spot at the neighborhood of the frænum in adults as well as in children.

Mr. Davies-Colley[1] advises that when forceps are used they should be removed when half of the skin is divided, and that the remainder of the section should be completed with scissors, sloping the cut forward so as to leave the skin longer on the under side. The use of Ricord's phimosis forceps is only of slight service, and that principally in adults. The operation may be done under cocaine by injecting a small amount of a one-per-cent. solution in the region of the incision.

If any venereal disease of the parts is suspected they should be thoroughly cleansed, and any abrasions on the fingers of the surgeon should be protected by collodion. Jacobson[2] has seen two cases of syphilis contracted by physicians in the reduction of paraphimosis.

HORNY GROWTHS OF THE PENIS.—The penis in the neighborhood of the glans is not only affected with ordinary vegetations and warts, but also in rare cases with true horny growths. Dr. J. H. Brinton[3] gives the details of such a case. The horn occurred in a man aged sixty-two, and grew from a wart. It was one and seven-eighth inches in length and was attached to both glans and prepuce. Fifteen cases including

[1] Guy's Hospital Reports, 1892, p. 163.
[2] Op. cit., p. 643.
[3] Medical News, 1887, vol. li., p. 141.

this one are recorded, as culled from various journals. In six cases horns grew after circumcision had been performed for phimosis. Others followed or were coincident with epithelioma of the organ, and nearly every case was preceded by a wart. Baldwin records another case in a youth aged nineteen. He was circumcised for phimosis, and from a soft warty growth a horn grew which became an inch long. This was removed, but recurred again nine months subsequently, when it was once more excised and the base cauterized with nitrate of silver. It then remained absent.

These horny growths occur in two forms—as plates and as horns.

They are to be treated by excision, but, as shown in the last case, it is necessary to excise or destroy the base of the growth, or recurrence will take place. In some cases the horn involves the end of the penis to such an extent as to render it advisable to amputate it instead of attempting excision. This was done in Brinton's case.

TUBERCULOSIS OF THE PENIS.—Tubercular disease of the male genital organs usually affects the testicles, the penis itself being almost never involved, though there appear to be a few cases in which the tubercular nature of the lesion has been established with reasonable certainty. Kraske's case[2] is well known. It occurred in a man aged forty-nine. There were two ulcers on the glans penis, which was amputated, when typical giant cells and tubercle bacilli were found. Kraske regarded the disease as the result of an infection through the blood, and not locally, because the disease was most marked in the deeper tissues. Another case is recorded by Malécot.[3] It occurred in a Jewish boy, fourteen years of age, who had been circumcised, as usual, eight days after birth. The ulcer surrounded the meatus and was of the size of a twenty-centime piece. Its aspect, softness, and lack of glandular enlargement, excluded hard chancre, while its smooth base, freedom from suppuration, and regularity, both of base and border, excluded chancroid. It was not painful. The patient had for three years been suffering with vesical symptoms, micturition being frequent, painful, and at times bloody. The tubercular nature of the ulcer was demonstrated by the inoculation of guinea-pigs. The patient, one year afterward, still had the ulcer in about the same condition, but in general health had somewhat improved under treatment.

The occurrence of a localized tubercular lesion of the penis as the result of direct local inoculation is certainly open to doubt; both of these cases are against it. The deep character of the lesion in Kraske's case convinced him that the infection was through the blood, and in the second case the presence of vesical disease certainly points to an infection of the genito-urinary tract which probably antedated the appearance of the glandular affection; at all events, it is just as reasonable, if not more so, to say that the ulcer of the glans was secondary to disease of the bladder, as it is to say that the penis was affected first and the bladder afterward.

These tubercular lesions of the penis from a clinical standpoint resemble, if they are not absolutely identical with, lupus as it occurs in other parts of the body, and may be treated in a similar manner.

[1] Medical News, 1887, vol. li., p. 449.
[2] Ziegler, Beiträge zur pathologischen Anatomie, Bd. iv., Heft 2.
[3] Annales des Maladies des Organes Génito-Urinaires, p. 838, 1893.

PRURITUS OF THE GENITALS.—Owing to a difference in nomenclature there is apt to be some misunderstanding concerning the two diseases, pruritus and prurigo. In Mr. H. Royes Bell's article on Injuries and Diseases of the Male Genital Organs, in Vol. VI., this affection was described under the name prurigo. He followed the not uncommon custom of English and French dermatologists.

In Germany and America, however, the term pruritus is used to express the condition in which itching exists without definite causative lesions, and the name prurigo is restricted to the disease of Hebra, which is a chronic affection, beginning usually in early life, and characterized by the appearance of small papules, principally on the extensor surfaces and accompanied with intense itching. It is comparatively rare, and Hebra considered it incurable. In the treatment of pruritus, as we shall call it, any sources of local irritation, with which it is so often associated, should be searched for. Hemorrhoids, particularly, should be removed, and the bowels should be carefully regulated. Vaginal discharges, the state of the bladder, kidneys, urine, etc., should also be attended to. A method of using tar in this affection which I have found of the greatest service is to employ a mixture of one part of tar ointment to two or three parts of oxide-of-zinc ointment. Pure tar ointment is apt to be too irritating.

Bronson[1] recommends the following: A drachm each of carbolic acid and liquor potassæ to an ounce of linseed oil. The mixture is to be shaken before being applied. Baths will sometimes relieve the itching. After a bath the surface of the body should be dusted with powdered starch, or with camphor and oxide of zinc, or with a recent pharmaceutical powder known as "compound stearate of zinc with menthol." Menthol may also be used dissolved in oil.

Cocaine is not of very much service unless excoriations are present. A saturated watery solution of boric acid may be recommended. In the pruritus of diabetics, Crocker advised painting the parts with nitrate of silver, ten grains to an ounce of the sweet spirit of nitre.

AFFECTIONS OF THE SCROTUM.

CONTUSIONS AND WOUNDS.—As the result of contusions large effusions of blood may form, and may so distend the scrotum as to render the diagnosis from hæmatocele of the tunica vaginalis one of some difficulty. Such a case recently came under my notice. The character of the injury and the manner of its reception, the discoloration of the skin, frequently extending to the thighs and abdomen, the limitation of the swelling and the more or less superficial character of the fluctuation may aid the surgeon in deciding as to the location of the effusion. In cases of doubt an evaporating lotion will cause the subcutaneous effusion to disappear rapidly, whereas a hæmatocele will be more apt to remain stationary.

Wounds of the scrotum, the result of operative procedures, should always be made with full antiseptic precautions.

There are few places of the body in which asepsis is so difficult to

[1] Morrow's System of Genito-Urinary Diseases, Syphilis, and Dermatology, vol. iii., p. 743.

maintain, or in which septic infection gives rise to more serious consequences. Even in such simple procedures as tapping, care should be taken to thoroughly cleanse the skin, and to use a trocar that has been sterilized by boiling.

SLOUGHING OF THE SCROTUM.—In sloughing of the scrotum poultices are commonly advised. These certainly hasten the separation of dead tissues, particularly if lightly dusted with carbonate of sodium; but in view of the extremely fetid nature of these cases some antiseptic is needed, and a good application is gauze saturated with hot solutions of weak bichloride of mercury, carbolic acid, permanganate of potassium, or boric acid.

Randolph Winslow[1] gives the detail of four cases in which gangrene of the scrotum followed the operation of excision of inguinal glands.

ELEPHANTIASIS OF THE SCROTUM.—Since Mr. Bell wrote his article in Vol. VI. of this work, this disease has been thoroughly studied by Dr. K. McLeod, of Calcutta,[2] and as his views have been generally accepted by the profession they will be given below. The method of controlling the hemorrhage varies somewhat. Turner[3] used a clamp made of two parallel pieces of wood, a curved notch being in the upper one; these are made to approximate and compress the parts by a thumb-screw at each end. Tillmanns and Kocher both advise the use of this clamp, while McLeod employs the elastic cord. The many varieties of hæmostatic forceps now in use also render the bleeding less to be feared than formerly. The following is taken from McLeod's article:—

The inducements to remove the diseased parts by operation are these: (*a*) The deformity and inconvenience caused by the growth, especially when it has attained a large size; (*b*) the sexual disability which it entails; (*c*) the discomfort caused by the periodical recurrence of fever; (*d*) the impairment of general health which results from these repeated attacks of pyrexia.

The contra-indications to operation are:

(*a*) Old age. In the aged, sexual disablement is not a matter of much consequence, and if the tumor has, as often happens, become stationary in its growth, and the concomitant fever ceases to occur, or becomes less frequent and severe, operative interference, which is always more hazardous in the old, should be considered with more hesitation and caution.

(*b*) Ill health and visceral disease. A weak or damaged heart, or disease of the kidneys or intestines, is prohibitory, as are also acute enlargements of the liver and spleen.

(*c*) *Complications.*—(1.) An abscess, if it exists, should first be cured. (2.) A stricture should be fully dilated. (3.) Very large hydroceles increase the risk, but are not a bar to operation. (4.) Hernia increases the risk, and the removal of the tumor with the cure of the hernia at the same time has been proven to be a perilous practice. (5.) Operation should not be resorted to when the tumor is in a state of excitement.

Operation.—1. Elevation and elastic bandaging of the growth for from ten to twenty minutes, according to size.

[1] Annals of Surg., Jan., 1886, p. 40. [2] Heath's Dictionary of Surgery, vol. ii., p. 399.
[3] Kocher, Die Krankheiten der männlichen Geschlechtsorgane, S. 21.

2. To prevent bleeding an elastic cord should be tightly applied around the root of the tumor before the removal of the bandage, and secured in position by tying with tapes to a waist belt.

3. Recurrence occurs if diseased tissue is left behind; therefore, even though the prepuce appear healthy, it should be removed close to the corona, and the V-shaped incision should be extended into the perineum to the verge of the anus. Transplanted skin should be taken from the abdomen or thighs, and not from the neck of the tumor; but a satisfactory result may in all cases be secured without flaps.

4. The first step consists in decorticating the penis. A director is introduced into the prepuce, which is slit up, and an incision is made from the root of the penis to this cut. The penis is then freed by the finger and knife up to the suspensory ligament, which must not be injured. A longitudinal incision is next made from the pubes to the fundus of the tumor, over one cord and testis. This is dissected out and confided to an assistant while the other is similarly dealt with. The three longitudinal incisions are now connected at their pubic terminations by two transverse cuts, which must be beyond the limits of the diseased tissue, and a circular incision is made around the rest of the neck of the tumor, when the mass is removed. The largest vessels will be found in the centre of the perineum and on each side of the pubes. The elastic cord should be gradually relaxed. Thirty to forty ligatures will be required.

5. The testes may be stitched together with catgut and fastened in depressions, or pockets, made by separating the deep layer of the superficial perineal fascia from the subjacent fat and areolar tissue.

6. To prevent suppuration, thorough irrigation with carbolic or sublimate lotion, and dusting with iodoform, should be employed. Excoriations should be covered with boric-acid ointment.

EPITHELIOMA OF THE SCROTUM.—In Vol. VI. of this work Mr. Royes Bell stated, in reference to chimney-sweep's cancer, that it was becoming a curiosity in his country (England). Lately the subject has been again agitated by Mr. Butlin in a carefully prepared article in the British Medical Journal for 1892. After describing the different methods pursued by chimney-sweeps in various countries, and thereby showing that the disease is most frequent where the workers are the least cleanly, he expresses the opinion that it is not decreasing. Mr. Jacobson[1] on the contrary, from an examination of the records of Guy's Hospital, holds that it is decreasing, and attributes this to the greater cleanliness of workers in soot. In America the disease is very rare. Professor Ashhurst had a case, however, which occurred in a worker in a gas-works.

AMPUTATION OF THE PENIS.

In consequence of the rapid progress which the belief in the local origin of carcinomatous affections is making, there seems to be a tendency to the performance of more extensive operations in malignant disease than were formerly thought justifiable. Dr. Meyer[2] holds that

[1] Op. cit., p. 559.

[2] Annals of Surgery, vol. xx., p. 179.

partial amputations of the penis should be abandoned. There are three things that it is desirable to bear in mind in amputating the penis for malignant disease. First, to remove the growth in such a manner as to render the patient least liable to a recurrence. Second, to so operate as to prevent after-trouble from the contraction of the new meatus. Third, to so place the new meatus as to enable the patient to pass his urine with the least amount of discomfort.

Amputations of the penis are composed of two classes: in one, the disease being near the extremity of the organ, the amputation is done in front of the pubes; in the other, the incision is carried farther back, involving the scrotum and perineum. The use of the écraseur, whether that of Chassaignac or the galvanic instrument, has been practically abandoned, as has also the method of Sir William Fergusson of severing the penis with a single sweep of the knife.

Smyly [1] first advised uniting the mucous membrane of the cut urethra to the skin; Erichsen followed his example, as did Demarquay and others. Demarquay made lateral flaps and left the urethra longer than the cavernous bodies, splitting it above and below, and sewing the mucous membrane to the skin. This is essentially the operation as it is done to-day. Some modify the procedure by making a single flap. The credit of this is given by Mr. Jacobson to Professor Miller, of Edinburgh, who made a long flap from the under surface of the penis. Mr. Jacobson himself prefers to make a long dorsal flap. The urethra, which is left a half or three-quarters of an inch longer than the cavernous bodies, is brought through a hole pierced in the flap, and the mucous membrane is stitched to the skin. Dr. Ashhurst attributes this piercing of the flap to Professor Watson, of Edinburgh. Another modification is that of Dr. Keller,[2] of St. Louis. He makes side flaps, unites the cut corpora cavernosa in front by deep transverse catgut sutures, and then adds a second vertical row of stitches through the skin. Sir William MacCormac [3] has shown that carcinomatous infiltration is more marked and progresses farther in the corpora cavernosa than in the spongy portion; so that the danger of recurrence is not made as much greater by the increased length of the urethra as might be expected. He found this condition to be present in all five of his cases.

Thiersch in 1865,[4] with the idea of making urination more convenient, advised isolating the urethra and fastening it into the lower part of the wound. Curtis [5] went a step further and made an incision on the anterior surface of the scrotum, into which he laid the long stump of the urethra, this being slit up to make a large meatus. The patient was thus enabled to throw a stream about two feet away from his feet, and there was no excoriation from dribbling, as occurs when the urethra is high up.

When simple amputation through the continuity of the penis is not advisable and it is necessary to go farther, then a much more extensive operation is required. The names of several surgeons have of recent years been associated with these operations, but this is hardly doing justice to their predecessors. Wedemeyer [6] gives the history of some of these earlier procedures. He states that Delpech, in 1832, brought

[1] Dublin Medical Press, 1839. [2] Brun's Beiträge zur klin. Chirg., 1889, Bd. iv., Heft 2.
[3] British Medical Journal, 1886, vol. i., p. 343. [4] Der Epithelialkrebs, S. 288.
[5] Annals of Surgery, 1894, p. 178. [6] Archiv der Heilkunde, 1877, S. 563.

the urethra out at the perineum and made a separate sac for each testicle. Lallemand in 1844 repeated the operation, as did Bouisson, twice, in 1855, and Roux in 1857. Thiersch adopted the same procedure in 1875 or 1877. In 1862 Wattmann[1] split the scrotum, encircled the penis, and then separated the corpora cavernosa from the rami of the pubis. The urethra was then fixed in the perineum and the scrotum was united.

Demarquay[2] says in describing the operation that "the two corpora cavernosa are dissected out until their insertion into the ischium is reached, when they are detached with care."

Mr. A. Pearce Gould,[3] before the Medical Society of London, described his method of operating. He split the scrotum, dissected out the urethra as far back as the triangular ligament, scraped off the attachments of the crura to the bone by means of a periosteal elevator, and stiched the urethra in the perineum. Wheelhouse,[4] in one case, after amputation of the penis removed the testicles also. He says that, although it added greatly to the severity and danger of the operation, the patient made an excellent recovery and many times spoke to him with the greatest gratitude and thankfulness for the complete relief afforded. Another patient in an adjoining bed, in whom the penis had been amputated without castration, said to Mr. Wheelhouse that he wished that while he had been about the business he had made a complete sweep of everything for him as well as for his neighbor. The testicles were, from first to last, a cause of trouble and distress. Soon after the operation they became swollen, and remained tender for some time; they were there as a possible seat for the return of the disease, and, by their physiological action, were a constant source of annoyance. Mr. Wheelhouse says that while one patient was, as far as possible, completely relieved, the other was only partially so. In a discussion on the subject before the Medical Society of London, Mr. A. Pearce Gould expressed himself against the removal of the testicles unless there was some special indication. He thought the necessity for sexual indulgence much overrated. Mr. J. Morgan doubted the propriety of subjecting the patient to the increased risk from shock, and Mr. Walter Pye, while he thought that the increased risk was hardly a sufficient objection, still considered the removal of the testes undesirable. Mr. Jacobson,[5] in referring to Mr. Wheelhouse's case, says that when the patient is advanced in life, or where his vitality is greatly depressed, castration should not be performed; but that in cases where there is reason to believe that castration will prove beneficial, he is in the habit of advising patients to have it done. In three cases they were most thankful for the result.

Mr. Reginald Harrison,[6] after passing a staff into the bladder, taps the urethra through the perineum and introduces a drainage-tube. Amputation of the penis is performed a week subsequently, the urethra being closed by a couple of stout catgut ligatures. This method of operating may be of service in cases of debilitated patients in whom a more severe operation would be likely to prove fatal.

[1] Linhardt's Operationslehre, 1862, S. 823.
[2] Maladies Chirurgicales du Pénis, p. 418. Paris, 1877.
[3] Lancet, vol. i., 1882, p. 821.
[4] British Medical Journal, 1886, vol. i., p. 1886.
[5] Loc. cit., p. 731.
[6] Surgical Disorders of the Urinary Organs.

Some surgeons, like Dr. Wyeth,[1] instead of splitting the scrotum in order to bring the urethra down and out at the perineum, have perforated it and brought the urethra out through the hole thus formed.

Diseases of the Testicle and Tunica Vaginalis.

Hydrocele.—Sometimes instead of there being only a single cavity filled with fluid there may be several, constituting what might be called a multilocular hydrocele. Kraske[2] gives two such cases. One occurred in a man aged twenty-four years. There were two distinct sacs separated by a septum, which was excised, and the hydrocele thus cured. The other case occurred in a man aged fifty-nine years. There were a large number of cysts, varying in size from that of a pea to that of a hen's egg. They contained fluid such as is usually found in hydroceles. There was also fluid in the tunica vaginalis. The same condition existed on the opposite side, but the cysts were smaller. After their removal, the testicle and cord were found to be so isolated as to threaten gangrene of the organ, so that this was excised.

Treatment.—It being recognized that some of the bad effects occurring after tapping a hydrocele have been due to the introduction of septic matter, far greater attention is now paid than formerly to guard against such an occurrence. The scrotum is to be shaved at the site of puncture and carefully cleansed. The trocar and canula should be sterilized by boiling, and after the completion of the operation the puncture should be closed with iodoform or benzoated collodion (equal parts of fluid extract of benzoin and collodion). Mishaps in tapping usually arise and are favored by employing a badly fitting trocar and canula, by operating before the sac is properly distended, or by failure to previously determine the location of the testicle. The canula should fit the trocar closely, and no attempt should be made to tap with a defective instrument. The increased pain so caused should alone forbid it. A dry tap is usually caused by the trocar and canula both penetrating the skin, but only the former entering the tunica vaginalis, the canula pushing the tunic in front of it so that when the trocar is withdrawn the canula remains simply in the cellular tissue and no fluid comes away. This accident is to be provided against not only by using a close-fitting instrument, but also by keeping the sac tense with one hand while the trocar is given a sharp, quick thrust with the other. By operating before the sac is distended it may be impossible to render it sufficiently tense to make a proper puncture, and the testicle is then liable to be wounded. If it does happen to get injured, the patient should be cautioned to remain quiet in bed, with the organ suspended until the outcome is evident. Mr. Teevan was accustomed to use quite short trocars of small diameter. These by a quick stab were driven in their full length. This plan of procedure is usually less painful than the operation with a longer trocar, but on account of its being slightly less certain in its results has not been generally adopted. The position of the testicle is usually at the lower, inner, and back part of the swelling, and, on careful palpation, the increased resistance and the sensations of the patient will usually enable the surgeon to deter-

[1] Annals of Surgery, vol. xx., p. 179. [2] Centralblatt für Chirurg., 1881, No. 47, S. 737.

mine positively its location. It is dangerous to rely solely on a feeling of fluctuation at the site of proposed puncture, because the testicle may be so soft, or the tunica vaginalis so thickened, as to cause a mistake on this point. Of course the use of a light will in most cases show translucency at the place of puncture.

In regard to the special mode of operating to be preferred in attempting a radical cure, the profession still seems to be somewhat undecided. The great advances which have been made of recent years in operative surgery and in the treatment of wounds, incline many surgeons to perform cutting operations. As regards treatment by injections, those of tincture of iodine and carbolic acid are the only ones that have survived. The use of carbolic acid has not supplanted the older tincture of iodine. Abscesses have occurred from its use, and also gangrene of the tunica vaginalis. Recurrences too have been at least as frequent as after the use of iodine. Some of these bad results have possibly been due to the injection of too large a quantity of the liquefied carbolic acid. Dr. Levis advised that only one drachm should be employed. Mr. Mansell Moullin [1] states that the failures after the injection of iodine amount to at least one-third, but he allows the iodine to escape, or even sometimes dilutes it with an equal quantity of water. Bramann [2] gives the percentage of failures in the Kiel clinic as three and two-tenths. This I believe represents about the true number. Professor Agnew, who had an immense experience, stated [3] that he could recall but a single case of failure, and that in a hydrocele sixteen inches in circumference with thickened walls. His method, following Syme, of Edinburgh, was to inject two and a half drachms of the pure tincture of iodine (iodine one part, alcohol twelve and seven-tenths parts, by weight), which he allowed to remain. The sac was carefully manipulated so as to insure the iodine coming into contact with every part of its interior. Jacobson [4] recommends the injection of from two to four drachms of the Edinburgh tincture. More failures have been attributed to the injection treatment than it is properly answerable for. Weakening the injection fluid and allowing it to escape have been responsible for most of them. The pain accompanying the use of iodine has been made an objection to it. With carbolic acid the pain is not so severe, but if it is desired to use the former substance, the preliminary injection, after removal of the hydrocele fluid, of a drachm of ten-per-cent. cocaine solution will suffice to make the pain bearable.

J. Neumann [5] introduces an aseptic trocar and leaves the canula in place, covering it with cotton and a bandage. It is allowed to remain for two or three days. In his six cases adhesion took place without inflammation or suppuration.

Buschke [6] pierces the sac with a trocar and introduces a drainage-tube which he fastens with a safety pin. The cavity is washed out with a carbolic lotion of from three to five per cent. Gauze may be used instead of the tube. It is removed in from four to six days, and during the treatment the patient is allowed to walk around.

Hebing [7] introduces from above downward through the sac, by means

[1] Surgery, p. 1143.
[2] Berliner klinische Wochenschrift, Bd. xxii., S. 259.
[3] Surgery, vol. ii., p. 576.
[4] Op. cit., p. 142.
[5] Wiener medizinische Presse, No. 45, 1893.
[6] L'Union Médicale, 1894, p. 399.
[7] Centralblatt für Chirurgie, 1894, No. 26, S. 596.

of a large curved needle, a double silk thread. The fluid is then removed by means of a large hypodermic syringe, and the ends of the thread are tied together. The three punctures are closed with collodion and the whole side of the scrotum is painted with the same. The thread is allowed to remain in place for from six to eight days, when it is removed and collodion is again applied.

Dr. O. Will[1] advises the use of a seton of silk thread moistened with tincture of iodine, and Jacobson recommends its employment in cases of encysted hydrocele in which the patient refuses a cutting operation.

There is no absolutely certain cure for hydrocele except a total excision of the secreting sac. This involves such an extensive dissection as to endanger the integrity of the testicle, and cannot be advised.

Volkmann's plan,[2] the credit of originating which, however, he gives to B. Beck—of incising the sac and suturing its edges to the skin, and introducing a drainage-tube—is regarded as being more sure than the use of injections. Bramann[3] says that Volkmann, in 163 cases, had no return, and that the operation was equally successful in the hands of Reyer, Czerny, Trendelenburg, and Kuester. Von Bergmann, Albert, and Rochelt, however, had some recurrences. Volkmann's method has now been to a great extent replaced by a return, under antiseptic precautions, to the old plan of excision pursued by Douglas, Pott, and Bell. This consists in excising the parietal layer of the tunica vaginalis, only leaving enough to cover the testicle and cord. Even under this procedure Morris[4] has had two recurrences, which he successfully treated by packing the sac with boric-acid lint. Incision combined with the application of chloride of zinc, carbolic acid, or nitrate of silver, has also been employed. Dr. Hearn, of Philadelphia, advocates the use of carbolic acid in this manner, and I too have used it with success.

Mr. Jacobson[5] prefers the application of the solid nitrate of silver stick after excision of the parietal layer, and believes it to be surer than the other remedies, while in his experience it has not been followed by either pain or orchitis.

CONGENITAL HYDROCELE.—The frequency of hydrocele in infants is claimed by Wechselmann[6] to be greater than has heretofore been supposed. Out of two hundred and seventy male infants whom he examined he found that thirty-seven had hydrocele. In fourteen of these the sac communicated with the peritoneal cavity, only two being on the left side, and both communicating with the peritoneum. In four cases the hydrocele was double. Most of the hydroceles were as large as a cherry, though some reached the size of a plum or were even larger.

While congenital hydrocele may be as frequent in newly born infants as Wechselmann claims, I am convinced, from a considerable experience in the surgical diseases of children, that it is not so in those who are a few months old. That the affection disappears spontaneously is well known, and this may account for the difference. While it is not at all uncommon in the outdoor service of our hospitals, still it does not ap-

[1] Edinburgh Medical Journal, Dec., 1888.
[2] Berliner klinische Wochenschrift, 1876, No. 3, S. 29. [3] Ibid., 1885, No. 22, S. 209.
[4] American Journal of the Medical Sciences, 1888, vol. xcvi., p. 156.
[5] Op. cit., pp. 150–155. [6] Archiv für Chirurgie, Bd. xxxvi., Heft 3.

pear with such frequency as one would expect were the proportion as great as that which Wechselmann gives.

VARICOCELE.—Varicocele is usually an affection of youth and young adult life, and inasmuch as it then makes its appearance it has been considered an acquired affection. Its immediate cause has been sought in derangements of the venous system, such as are observed in hemorrhoids. That this is a correct view is certainly doubtful, and it is quite probable that some congenital peculiarity exists which favors the production of the malady.

McGraw[1] believes that an interference with the proper performance of the function of the cremaster muscle is an important factor. He claims that the function of this muscle is to empty the spermatic veins, and that it does this by contractions caused by the stimulus or irritation produced by their overdistention.

Lydston[2] strongly insists upon the dependence of varicocele upon alterations of the condition of the general venous system, and gives the case of a man, aged thirty-nine years, who applied for the relief of a double varicocele. The abdominal veins and also those of the legs were remarkably enlarged. He also had hemorrhoids. His mother had been a delicate woman, and had suffered from severe varices of the extremities. She had died of pernicious anæmia. One of his brothers was troubled with severe nævi located on the inner aspect of the thigh.

Tillmanns[3] regards a congenital predisposition to the disease as an important element, and Treves[4] says that the congenital origin of the affection is generally allowed. The difference in their mode of emptying of the two spermatic veins; the fact, as pointed out by Spencer, of the larger size of the vein of the left side; and the passage of the left spermatic vein behind the sigmoid flexure, are congenital and not acquired peculiarities; and that disease of the veins themselves may be hereditary is shown by Lydston's case above quoted.

The necessity of operation in this disease is sometimes overrated, and its bad effects magnified. While Curling thought that softening and atrophy of the testicle sometimes occurred, the true view is expressed by Mr. Jacobson[5] when he says that "save in varicoceles of very large size and rapid formation, serious atrophy is not to be feared." He also cautions against mistaking simple softness for atrophy, and Keetly[6] says that even an atrophied testicle is not necessarily functionless.

The infrequency of the affection in mature adults is in itself a protest against indiscriminate operating, and demonstrates the ability of nature itself to cure the majority of cases.

Operation.—There are three operations usually practised, viz.: excision of the redundant scrotum, subcutaneous ligation, and ligation by open incision; my preference is for the last-named method as a rule.

Mr. Bennett,[7] while advocating the open method of excision of the veins, characterizes excision of the scrotum, which is a very old operation revived more recently by Dr. Henry, as useless in practice and unsound in theory. Reginald Harrison[8] also does not advise it, but

[1] Journal of the American Medical Association, vol. xix., 1892, p. 193.
[2] Medical News, Nov. 26, 1892.
[3] Lehrbuch der speciellen Chirurgie, Bd. ii., S. 345.
[4] Operative Surgery, vol. ii., p. 635.
[5] Op. cit., p. 525.
[6] British Medical Journal, 1894, vol. i., p. 860.
[7] Lancet, 1889, vol. i., p. 265.
[8] Surgical Disorders of the Urinary Organs, p. 536.

Reclus,[1] as late as 1893, has advocated it very strongly. He claims that incontestable cases of eunuchism have resulted from operation on the cord, and cites three cases of gangrene, one in his own hands, that have occurred from it. He also holds that it is less radical than supposed, and that it leaves the scrotum flaccid and pendulous. He gives a case of recurrence in which he afterward operated by excising the scrotum, the patient being well five months after the latter operation. Wickham, Championnière, and Ségond are also champions of this procedure. Guyon resects both scrotum and veins. Reclus has resected the scrotum for varicocele during seven years with satisfaction. He has operated twenty-nine times, and in four cases seen afterward found that the patients remained well at thirty-five months, thirty months, twenty-two months, and nineteen months, respectively.

The subcutaneous operation on the veins still has a stanch advocate in Dr. Keyes, of New York. Mr. Mitchell Banks[2] ligates the veins in two places with catgut and divides them between the ligatures. Keyes,[3] in 1886, advocated subcutaneous ligation of the veins with silk, using his modification of Reverdin's needle.

Notwithstanding the progress that the open mode of operating has made in the opinion of the profession since that date, he still[4] advocates the subcutaneous method. He applies three ligatures, one reasonably high up on the cord, another close down to the testicle and globus major, and the third below the testicle at the globus minor. He employs strict antiseptic precautions and has never had an abscess, although there has sometimes been some oozing of sero-pus. In only three instances out of over a hundred or more cases has the silk worked out.

Operation of Excision of the Veins.—The most generally accepted operation at present is antiseptic excision of the enlarged veins. It owes its introduction largely to Mr. Howse,[5] Mr. Jacobson,[6] and Mr. Bennett.[7] The bowels having been previously emptied by a laxative, the parts, on the day previous to the operation, are carefully washed with soap and water, and shaved, and then cleansed with ether and bichloride solution, 1-2000, and wrapped up in gauze wet with the same. This is allowed to remain until the time of operation. One assistant draws the testicle of the affected side downward until the cord is tense. An incision an inch and a half long is made over the dilated veins; a very slight parting of the tissues exposes them, and while they are lifted up with forceps the operator recognizes the vas deferens by touch, and entrusts it to the care of the assistant, who grasps it with his disengaged left hand and thereby prevents any accident occurring to it. With two pairs of forceps, or with one pair and a knife, the evidently enlarged veins are isolated to the extent of the external incision. Mr. Jacobson, having seen gangrene follow in one case, advises that only two-thirds of the veins should be isolated, and that the other third should be allowed to remain. Catgut ligatures are next placed around the separated veins, first below and then above, and the inter-

[1] Gazette Hebdomadaire, 1893, p. 135.
[2] Clinical Notes, 1884, p. 114.
[3] Medical Record, Feb. 20 and Sept. 18, 1886.
[4] Morrow's System of Genito-Urinary Diseases, vol. i., p. 971. 1893.
[5] Guy's Hospital Reports, 1887.
[6] Holmes's System of Surgery, 3d edit., vol. iii., p. 571.
[7] Lancet, Feb. 9, 1889, and March 7, 1891.

vening part is removed, taking care to leave the stumps long enough to avoid all danger of the ligatures slipping. The ends of the ligatures are to be tied together (Bennett), thus bringing the two stumps of the divided veins in contact. If necessary to insure better approximation, an additional catgut suture may be inserted. The skin may be approximated by the subcutaneous suture, or by from two to four catgut sutures, great care being taken to see that the edges are not inverted. In order to guard against this inversion, one or two deep relaxation sutures may be inserted by passing a needle threaded with catgut a quarter of an inch from the edge of the wound, and then back again a short distance from and parallel to its first position, and tying the ends of the thread.

It is the practice of some surgeons to use silk ligatures, but the swelling which so readily occurs in this region may render their removal difficult and painful, and, besides, union usually occurs so rapidly as to render their use unnecessary. Some likewise immediately seal the wound with iodoform-collodion, but I distrust it. A drain is unnecessary, but if used it may consist of a strand of horsehair or catgut, and should be removed on the first or second day following the operation. When allowed to remain longer *in situ* it is liable to convey infection to the wound if, as is apt to occur, by any means the movements of the patient displace the dressing. Mr. Bennett judges of the length of the veins which it is desirable to remove by observing how much lower one testicle hangs than the other, but this is apt to lead to a more extensive removal than I believe to be necessary. Mr. Jacobson removes a strip of skin from each side of the incision, in order to brace up the parts, and also sometimes ligates any enlarged scrotal veins which may be present.

Sometimes the scrotum is so exceedingly long that it is desirable to resect a portion of it, as otherwise, after healing, it will be found hanging almost as low down as it was before. When this is done, the use of the subcutaneous suture, or of the deep relaxation suture of catgut, as already described, with a superficial continuous suture, is particularly useful, as a long scrotal wound will not infrequently become inverted and healing be thereby much delayed. A careful antiseptic dressing should be applied with a large pad of absorbent cotton over it. Through this the penis is made to protrude. The dressings may be retained in place by a T-bandage. In applying the bandage the point of crossing is placed on the abdomen, and the transverse tails are tied around the body. The longitudinal tail, which should be eight inches in width, is to be brought down in front and an opening made for the penis. The remaining portion is then torn into two strips until a point corresponding to the perineum is reached. The two tails thus formed are brought around each thigh, and then up, and are fastened to the part around the waist near its junction with the longitudinal strip.

ANOMALIES OF THE TESTICLE.

UNDESCENDED OR MISPLACED TESTICLE. (*Ectopia Testis.*)—Since Mr. Bell reported the operations of Mr. Annandale and Mr. Wood for replacing an undescended testicle in the scrotum, the operation has

been quite extensively practised. When the testicle could be forced out of the inguinal canal, Mr. Wood recommended the application of a truss to prevent its return. Tuffier [1] recommends repeated traction as favoring the descent of the testicle. He does not advise operation until after the age of fifteen.[2] One of the difficulties in the way of operative success has been the tendency of the testicle to re-ascend. Wood and Annandale, to prevent this, stitched the testicle to the bottom of the scrotum. Watson Cheyne [3] passed a thread through the structures of the cord and attached it to a wire cage. Bidwell [4] operated on three cases as follows: He made an incision as for the radical cure of hernia, but did not cut the scrotum. The cord was then loosened, and the testicle inverted and placed in the scrotum, a thread being passed through its lower part and fastened by means of an elastic tube to the wire cage of Cheyne. The elastic traction dragged the testicle down into the scrotum by the third day. The tunica vaginalis was opened and divided just above the testicle, the abdominal end being closed by a ligature. Lucas Championnière [5] lays stress on dividing all adhesions, then preventing the receding of the testicle by thoroughly closing the upper part of the scrotum and external ring. Keetly,[6] after suturing the divided tunica vaginalis over the testicle, carried a piece through a puncture in the scrotum and sutured it to the deep fascia of the thigh. Broca [7] regards unfavorably the attempts to prevent upward recession of the organ by means of a cord or thread running from it to some fixed point below. This object is rather to be accomplished by means of a firm closure of the canal from above downward. Terrillon [8] operated on six cases in children from nine to fifteen years of age. In three the testicle remained down, and became enlarged; in one it became enlarged, but was drawn up again in spite of a truss; while in the other two it was drawn up again and did not enlarge, though two and two and a half years respectively had elapsed. When the testicle is retained it is covered by peritoneum and bound down by tough fibrous adhesions. It is atrophied, and its removal is advised. Mr. Jacobson [9] prefers operating between the ages of eight and ten, before sexual changes set in, as misplaced testes tend to degenerate, while if replaced they grow and develop better. In children of the poor, where time is an object, he considers it justifiable to operate earlier, especially if a troublesome hernia coexists, or if there have been attacks of pain. Before the age of two or three years operation is inadmissible.

Besanzon [10] advises operation when other means of treatment have failed and the testicle is movable. The best time he claims to be between the ages of eleven and thirteen years. The radical operation for hernia should be done at the same time. In some cases the testicle descends spontaneously. McBurney [11] records a case of sarcoma occurring in the undescended testicle of a young man.

Two rare cases of strangulated hernia associated with misplaced testi-

[1] La Semaine Médicale, 1889, p. 125. [2] Gazette des Hôpitaux, 28 Mars, 1890.
[3] British Medical Journal, vol. i., 1890, p. 351.
[4] Lancet, June 17, 1893, vol. i., p. 1439.
[5] Bulletin de la Société de Chirurgie, 1887, p. 658.
[6] British Medical Journal, 1894, vol. i., p. 860.
[7] Gazette Hebdomadaire de Médecine et de Chirurgie, 15 Oct., 1892.
[8] La Semaine Médicale, 13 Janv., 1893. [9] Op. cit., p. 485.
[10] Centralblatt für Chirurgie, No. 13, 1894. [11] Annals of Surgery, vol. xvii., p. 448.

cle are described by Heaton.[1] The first was in a man aged twenty-seven years, who had had a reducible congenital hernia on the right side with undescended testicle. Strangulation occurring, the sac was opened and the gut readily reduced, but the patient died on the fifth day of internal strangulation. On post-mortem examination the testicle was found toward the iliac fossa, where it had dragged with it a pouch of peritoneum which lay between the general peritoneum and the wall of the abdomen. This pouch had a diverticulum which passed into the scrotum. The included intestine had been pushed up from the scrotal diverticulum into the main pouch, the opening into which was the seat of the constriction. The other case occurred in a man aged forty-five years. He had an undescended testicle which was accompanied by a lax bag of fluid. Symptoms of strangulation occurring, an incision over the tumor gave vent to two ounces of clear hydrocele fluid; a thick-walled tumor was found at the bottom of the sac, as also an atrophied testicle. The swelling being opened, about six drachms of dark serum escaped, and a ragged opening was seen leading into a third sac, which contained a coil of strangulated intestine. It was evidently a strangulated hernia which had in its descent pushed before it the enlarged tunica vaginalis of an undescended testicle as it lay in the inguinal canal—in other words, it was an example of the strangulated encysted hernia of Sir Astley Cooper.

INFLAMMATION OF THE SEMINAL VESICLES.—This usually occurs secondarily to inflammations of the urethra, gonorrhœa being its most common origin. According to Mr. Jordan Lloyd[2] it rarely terminates in suppuration, but when it does, the abscess should be punctured through the perineum and not through the rectum.

Ullman[3] advises excision of the seminal vesicles when they are affected primarily with tuberculosis, and when, in primary tuberculosis of the testicle or epididymis of one side, there is involvement of the seminal vesicle of the same side, the remaining organs of the opposite side being healthy. He operated as follows: A semilunar incision, concave toward the sacrum, was made in the perineum midway between the anus and the scrotum. A careful dissection was then made and the prostate exposed. The rectum was pressed back and the bladder caused to protrude by means of a sound in the urethra. By these means the seminal vesicles and vasa deferentia could be distinctly seen. Both the right and left vesicles were removed, together with a part of the prostate. The left vas was left in place. A drainage-tube was inserted and the wound sutured. Hemorrhage afterward occurred, for which the wound was packed. In all reported cases of tuberculosis of the seminal vesicles impotence has followed in a short time.

SPERMATOCELE AND SPERMATIC FISTULA.—The occurrence of a fistula of the testis discharging semen is probably unknown. Mr. Curling objects to applying the term to the cases of encysted hydrocele which contain spermatozoa, and it is usually restricted to such cases of retention of semen in obstructed ducts as resemble those which occur in the mammary gland. The nearest approach to this supposed affection

[1] Lancet, Jan. 27, 1894. [2] British Medical Association, meeting of August, 1888.
[3] Centralblatt für Chirurgie, 1890, S. 137.

which I have seen occurred in a young man aged twenty-six years. He gave the following history: He was addicted to masturbation, and over a year previous to coming under observation, when ejaculation was about to occur, stopped it by grasping the penis firmly with his hand. He experienced a sudden, sharp pain in the right testicle which immediately began to swell, so that by the third day it was as big as a fist and very sore. He then knocked it on the gunwale of a boat, when it broke and discharged pus. It never entirely healed, but left a sinus which he claimed discharged semen, and not pus, whenever he had a movement of the bowels, and sometimes through the day. Having had the discharge for a year he insisted on having the testicle removed, which was done. The sinus was found to lead down to a fibrous mass in the epididymis, with some granulation tissue strongly suggestive of tuberculosis.[1] The wound healed kindly. He gained twenty-six pounds in weight during the two months following the operation. Soon afterward he returned with a small collection of typical tubercular pus at the site of the operation. This case I regard as one of suppurating tubercular disease of the epididymis. Although no phthisical family history could be elicited, he had the typical appearance of a tubercular subject, and the thick, curdy, lumpy pus in the recurring abscess demonstrated conclusively the tubercular nature of the disease process. That he really did have a discharge of semen through the fistula seems to me to be impossible, for the fibrous matting together of the structure of the epididymis must have occluded the lumen of the vas deferens.

NEURALGIA OF THE TESTIS.—Pain in the testis is sometimes so distressing to the patient as to require radical treatment. Mr. Reginald Harrison[2] in such a case performed an operation of which he gives the following account: Having seen, in performing the open operation for varicocele, certain variations in the arrangement of the nerves which supply the spermatic cord, and which he regards as being derived from the sympathetic, he exposed the cord by a linear incision just below the abdominal ring. Having teased out the nerves, or rather the cellular nidus in which they were surrounded, from the structures of the cord, as far as he was able, he removed them with a pair of small curved scissors. The parts were carefully adjusted with catgut sutures and healing soon took place. The relief was so great that a few months afterward the patient requested that the same operation should be done on the remaining side. This was accomplished, and subsequently he remained free from pain, while no change was observed in the testicles.

STRANGULATION OF THE TESTICLE FROM TWIST OF THE CORD.—Dr. Johnson, of Baltimore,[3] reports a case of strangulation of the testicle in which the cord had a series of twists. It occurred suddenly in a man while blowing a cornet, and gave rise to some of the symptoms of strangulated hernia. In a further article on the same subject[4] he has collected fourteen cases, including his own. To these may be added that of Van Liveringen.[5] It occurred in a boy aged thirteen years, who was idiotic and a confirmed masturbator, and who probably got the

[1] Surgical Disorders of the Urinary Organs, p. 39.
[2] Annals of Surgery, March, 1893, p. 282.
[3] Ibid., May, 1894, p. 530.
[4] University Medical Magazine, April, 1893, p. 551.

testicle twisted in his idiotic manœuvres. It was gangrenous when excised, the cord being twisted.

In eight out of these fifteen cases the testicle is recorded as being undescended.

Dr. Johnson presents the following scheme of differential diagnosis:

Strangulated Testicle.	Strangulated Hernia.	Bubo.
Moderate shock.	Marked shock.	No shock.
Possible strain.	Probable strain.	History of sore or venereal disease.
Undescended testicle often.	Normal testicle.	Normal testicle.
External abdominal ring empty.	Occupied.	Ring empty.
Cord twisted but not obscured.	Cord obscured.	Cord normal.

The treatment consists in incision. All of the patients recovered.

BENIGN FUNGUS OF THE TESTICLE.—Owing to the advances made in the pathology of tubercular affections since Koch's recognition of the tubercle bacillus in 1882, most of the cases which were previously regarded as benign fungus are now known to be of a tubercular nature. Herniæ of the testis following syphilis are comparatively rare, as are the cases caused by wounds or sloughing, as from extravasation of urine. The superficial variety, in which the granulations do not come from and are not associated with testicular tissue, but simply spring from an exposed tunica vaginalis or tunica albuginea, are not properly fungoid affections, and fungus associated with malignant disease is an outgrowth of malignant tissue and anything but benign. So that the appellation benign fungus of the testicle really has comparatively little place in the pathological history of the organ. Shield [1] has studied the suppurative affections of the testicle, and as any suppuration of the organ may give rise to a more or less fungoid growth, the varieties which he gives are here appended, viz.: A considerable proportion are due to the softening and disintegration of tuberculous or syphilitic material. It occurs rarely from gonorrhœal inflammation. Orchitis complicating operations on the bladder and urethra may terminate in suppuration. A certain proportion are due to the sequelæ of specific fevers, especially typhoid, or result from pyæmia. Abscess may also follow injuries, and certain cases have been seen to occur, especially in infants, without definite cause.

TUBERCULOUS DISEASE OF THE TESTIS.—Tuberculous disease of the testis presents itself clinically in two forms: either as existing apparently alone, without other demonstrable lesion, or as associated with other tubercular affections. It is in the former case that operative procedures are of most service.

Inasmuch as all tuberculous diseases are regarded as being caused by the bacillus tuberculosis, the question arises, How does it obtain an entrance and locate itself in the testicle and epididymis? Strümpell [2] believed that infection took place through the urethra, but this view has not been accepted by others. It is contrary to the course which the disease pursues. The vas deferens is often attacked, but it is not in-

[1] Medico-Chirurgical Transactions, vol. lxxiv., p. 69.
[2] Münchener medizinische Wochenschrift, 1887, No. 31.

vaded from the side of the urethra, but by extension of the disease from the epididymis. The true explanation is to be found in the carrying of the bacillus by the blood to the testicle from some distant part, and in its localization, occurring through the establishment of a *locus minoris resistentiæ*, as happens in tuberculous disease of the bones and joints. Mynter[1] holds that the source of infection is undoubtedly the lymphatic glandular system, particularly the bronchial glands. While it is well known that the bronchial glands are often infected by the tubercular process without that fact being known during life, and that they are amongst the first organs to become involved, still, my own belief is that the testicles become infected by bacilli, floating in the blood, which have obtained their entrance into the system through some lesion of the air passages.

We know that the caseous glands so common in the young are, practically, and in all probability absolutely, primary centres of the tubercular process, and that these foci being removed the cure remains permanent. In many cases of tubercular disease of the testis, after excision of the affected organ the patient never has a recurrence. This would not be the case if a focus for the dissemination of the disease still remained in the bronchial glands; the operation would then soon be followed by outbreaks in other parts of the body. Tuberculosis is essentially a malignant disease. While not so fatal in its topical manifestations as is carcinoma, it shows the same tendency to metastasis by means of the blood and lymph currents, and rapidly extends itself locally. The epididymis is usually the part first involved in these cases, and from it the disease extends to the testicle on the one side and to the prostate gland, bladder, and kidneys on the other. It is the rule for the genito-urinary tract to be invaded from below upward. It does sometimes occur for the bladder to become infected secondarily to disease of the kidney, but this is very rare. The localization of the tubercle bacilli in the epididymis is claimed by Saltzmann[2] to be due to the peculiar character of its blood-vessels. He has shown them to be smaller and more tortuous than those of the testicle itself or those of the vas deferens. The head of the epididymis is more often affected than the tail. Frequently both testicles are involved. Finkh[3] found both testicles affected in nine out of twenty-nine cases, and Reclus[4] in twenty-one cases out of seventy-nine.

The testicles are not always involved simultaneously, but sometimes one after the other. When the testicle itself is invaded it is usually secondarily to disease of the epididymis. The organ may be affected in general miliary tuberculosis, but the condition is then overshadowed in importance by the disease in the lungs. The tubercular process propagates itself by direct continuity of tissue. It travels up the vas deferens and involves it and the vesiculæ seminales.

The belief is strong in the profession that a tubercular focus, such as occurs in this affection, will, if allowed to remain, serve as a point from which the disease will spread to other parts of the body. Mr. Jacobson[5] speaks positively on this point when he says that tubercle of the testis is

[1] Annals of Surgery, vol. xvii., p. 430.
[2] Centralblatt für klinische Medicin, 1888, No. 11.
[3] Bruns, Beiträge zur klinischen Chirurgie, 1886, Bd. ii., S 407.
[4] Du Tubercule du Testicle.
[5] Op. cit., p. 358.

to be looked upon as, if left to itself, an ultimately fatal disorder. That it is so in a large number of cases is probably true, as the disease, though it may remain quiescent for months or even years, shows a marked tendency to reappear. This temporary subsidence is what has caused some of the milder cases of hernia testis to be regarded as benign. The disease extends from the epididymis to the testicle and vas deferens. Its involvement of the seminal vesicles has already been alluded to. The affection also invades the prostate, producing abscesses, and then attacks the bladder, ureters and kidneys, producing one of the most distressing affections known in surgery. Finally the lungs are attacked and the scene closes.

Simmons[1] found that in thirty-five autopsies in cases of genital tuberculosis, thirty-one patients had the lungs affected. Gaule[2] found one case of kidney abscess and five of general miliary tuberculosis in eighteen autopsies for genital tuberculosis. Finkh[3] obtained the subsequent history of twenty-nine patients on whom castration had been performed. Of these, fourteen were still living and free from disease. Nine of the fourteen had had disease of one testicle only and the other five of both testicles. Of the nine in whom only one testicle had been diseased and removed, one was still well after an interval of twenty-nine years, one fifteen, one fourteen, one thirteen, one six, two over five years, one two years, and one one year after the operation. Of the patients from whom both testicles had been removed, one was well ten years afterward, one three years, two a half year, and one a quarter of a year. Eight patients had died in the interval of non-tuberculous diseases. In five of these only one testicle had been removed, and one had remained free twenty-two years, two three years, one three-fourths of a year, and another eleven years. In the three double cases, one patient had remained free for thirty years, one for five years, while the third had lived only twelve days. This last patient was sixty-three years of age, and died probably of the operative procedure.

In another case of double extirpation the patient lived twenty-three years and died of some unknown disease.

Six patients of the twenty-nine operated on died of tuberculosis: of these one died four years after the operation, of tuberculosis of the lung; one two years afterward, also of lung affection; one after two years of lung and kidney disease; one of lung disease a half-year after operation; one three months after, with caries of the spine and tuberculosis of the liver; and one in three weeks with general miliary tuberculosis.

As to how far Mr. Jacobson is right in regarding tuberculous disease of the testis as an ultimately fatal disorder, is certainly an open question. To have only six out of twenty-nine patients die of a recurrence of the disease, is surely not a malignant history. The affection after castration pursues much the course of the localized tuberculoses in other parts of the body, and we know that they are not necessarily fatal, but that in fact large numbers of them end in recovery. It is only necessary to refer to cases of coxalgia, Pott's disease of the spine, tubercular arthritis of the knee, and glandular affections. Recoveries from these,

[1] Deutsche Zeitschrift für Chirurgie, Bd. xviii., S. 157.
[2] Virchow's Archiv, Bd. lxix.
[3] Bruns, Beiträge zur klinischen Chirurgie, 1886, Bd. xi., S. 407.

even when no operative interference has been practised, are common. Notwithstanding this, it still remains true that, while tubercular disease of the testis may remain quiescent for a long time, it still is apt to start into full activity at any moment, or on the occurrence of any disturbance of the parts. The functional value of the organ is certainly diminished if not entirely absent. Mr. Curling[1] well expresses the condition when he says that in tubercular disease of the gland the secretion of semen, if not abolished, is small in quantity, and is scantily furnished with spermatozoa. When the disease obstructs the vas deferens it is evident that the organ has no functional value. To allow a tuberculous deposit to remain in one testicle directly favors the outbreak of the affection in the other. In from twenty to thirty per cent. of all cases both testicles became attacked, while in Finkh's twenty cases in which only one testicle was diseased and removed, there was not a single instance in which the disease attacked the remaining testicle. Our conservative means of treating a tuberculous testicle are of almost no value. They consist in suspension of the affected organ, a residence at the seaside, and the administration of cod-liver oil, syrup of the hypophosphites, and other tonics. They are palliative rather than curative. When one testicle only is affected, then, in view of the facts, that conservative measures are almost useless; that even if a temporary subsidence should occur the benefit would only be temporary; that there is a great probability of the other testicle becoming speedily involved; that the function of the organ is impaired or destroyed; that the prognosis after castration is good (only 6 out of 28 patients having recurrences); and that life is positively endangered if an operation is not done—I am of the firm belief that the diseased testicle should be at once removed. When one testicle only is affected, partial operations, such as partial excision or curetting, should only be done when the patient will not consent to the removal of the entire organ.

The disease should be attacked at once. That there may be only a single nodule is no excuse for delay. It simply gives time for the affection to extend itself. How often does one see in an excised testicle a single large focus surrounded by a number of smaller and more recent nodules? As soon as the condition is seen and positively diagnosed the testicle should be removed, or if this is not allowed the affected spot should be excised, or at least opened up and all the diseased tissue possible scraped and curetted away.

When both testicles are affected I still believe that it is to the patient's interest to have them both excised, but as consent will be still more reluctantly given, under these circumstances, the surgeon will be more often forced to resort to only partial procedures. When castration is done the cord should be severed high up, as it also is liable to be diseased.

TUMORS OF THE TESTICLE.—The subject of new growths of the testicle is still more or less obscure. The subject as yet has not been satisfactorily elucidated. That this uncertainty exists is due largely to the fact of the varied and complex nature of the various growths. It is comparatively rare for a tumor of the testis to be simple in character: most often it is complex. Indeed, in many cases it is almost impossible

[1] Diseases of the Testis, p. 448.

to say to which class of tumors the growth belongs, on account of the difficulty in deciding as to which part is the most important. This is particularly so in regard to the question of malignancy and non-malignancy.

There seems to be an exaggerated opinion prevalent in the profession as to the possibility of determining the true character of a growth by means of a microscopical examination. Since this instrument has come into common use, the tendency of surgeons is too often to excise a tumor and immediately send a piece of it to a microscopist to determine its character. This is not the right way. One of the obstacles that has contributed largely to our ignorance of these growths is a lack of proper pathological histories. In some cases a macroscopical examination, together with the clinical history, will determine a tumor's character. A microscopical examination will often be of service, but alone is apt to be misleading and untrustworthy. In some cases the most careful search into the clinical history, and the most minute examination of the growth itself, will fail to settle the question of malignancy. Cartilage is often associated with sarcoma, and as often, or still more often, with fibroma. Cysts are associated with both malignant and non-malignant growths in the same way, so that these tumors require to be studied in all their various aspects, both as regards their life histories and their macroscopical and microscopical appearances.

Adenoma and Cystic Disease.—The term adenoma is applied to those tumors which resemble in their construction glandular tissue: that is, they are composed of cavities the walls of which are lined with epithelium on a basement membrane. The name is not applied to those tumors in which, as in the sarcomata, a cyst forms, usually from a degenerative process, in the substance of the mass. These growths have been called cystoma, adeno-cystoma, fibro-cystoma (Eve), cystoma simplex (Kocher), hydatid disease of the testicle (Sir Astley Cooper), etc.

J. Bland Sutton[1] holds that these cysts take their origin from the organ of Giraldès, or paradidymis, a remnant of the mesonephros (Wolffian body).[2] This lies at the upper portion of the testis, between it and the head of the epididymis. Mr. Curling[3] held that they originated in the rete testis. Mr. Eve[4] states that while there are grounds for believing that the tubules and cysts originate in certain elementary outgrowths from, or rudiments of, the Wolffian body, existing through life in the hilum testis, it is still incorrect to say that they are derived from the organ of Giraldès, for it is situated outside the testicle while the cysts originate within. Mr. Sutton[5] considered the affection analogous to that seen in the congenitally cystic kidney, but Mr. Lockwood[6] combated this idea and Mr. Eve agreed with him. The disease to which it seems to me to bear the greatest resemblance is the cystic adenoma of the female breast. We see the same kind of cysts, lined and filled with similar epithelium, containing at times similar intracystic growths, and pursuing the same benign course without local recurrence or metastasis.

The cysts of the testicle are found in a fibrous matrix sometimes so

[1] Lancet, 1887, vol. i., p. 254.
[2] Tumors, Innocent and Malignant, p. 47. 1893.
[3] Diseases of the Testis, p. 382.
[4] Trans. Pathological Soc. of London, 1887, p. 201.
[5] Lancet, 1887, vol. i., p. 254.
[6] British Medical Journal, 1887, vol. i., p. 501.

abundant as to form the bulk of the tumor. So prominent is this that Mr. Eve has called the tumor a fibro-adenoma. They are often found associated with cartilage, and also, though less frequently, with myxomatous tissue.

The epithelium of the cysts is derived from the tubes of the rete testis and vasa efferentia. In two out of twelve cases ciliated epithelium was found. The cells vary in shape from the flat or tesselated variety to the spherical.

Mr. Eve does not regard the distinction between the benign adenomatous, or, as he terms them, fibro-adenomatous, and the malignant sarcomatous growths, as being at all marked. He strongly believes that there is no genetic difference between the two, and that their origin is similar though their structure is different, the cystic being the part most developed in the fibro-adenomas. This brings up the question as to whether a malignant disease is so *ab initio*. A scirrhus of the breast is usually so regarded, but on the other hand a benign wart is readily transformed into a malignant epithelioma.

Dalziel[1] reports an interesting case in which the whole epididymis was found converted into a mass of cysts. There were two large cavities, the larger being the size of a walnut. The rest of the epididymis was a mass of honeycomb-like cells of various sizes, from that of a pea downward, separated by the irtranslucent walls, there being no solid tissue at all. There was spermatic matter in one of the cysts. The growth occurred in a man sixty years of age, and was of twelve months' duration. It is interesting to note that this case was at first mistaken for and treated as a hydrocele. Removal is the only treatment for cystic as well as for all other tumors of the testicle.

Dermoid Cysts of the Testicle.—According to Mr. Sutton[2] there are many good reasons for believing that the majority of dermoid cysts reported as arising from the testicle really originate in the scrotum. Mr. D'Arcy Powers[3] reported a case to the Pathological Society of London which he believed to be the first presented in the history of the society. Verneuil, after examining all existing literature, was in 1855 only able to find ten cases. Mr. Powers's case occurred in a child four years of age. The growth had been noticed three years, and was freely movable in the scrotal sac. The testicle measured two and a quarter inches in length and one and three-quarters inches in thickness. The tumor occupied the whole body of the testis, and was enclosed by the smooth and somewhat thickened tunica vaginalis, which, however, was not adherent to it. On section it was found to contain a number of cysts, with some cartilage in the septa between the cysts. The glandular tissue had entirely disappeared. The wall of the largest cyst consisted of an epithelium and corium, and contained long and delicate hairs. There were well-developed sebaceous glands and hair follicles, each containing a non-medullated hair. The connective tissue was dense and possessed many of the characters of embryonic fibrous tissue. The large cyst occupied the posterior border of the organ.

Van Hook and Dodds record[4] the case of a man, aged twenty-one,

[1] Glasgow Medical Journal, vol. xxxvii., 1892, p. 144.
[2] Op. cit., p. 282.
[3] Trans. Path. Soc. London, vol. xxxviii., p. 224.
[4] Chicago Medical Recorder, 1891, vol. xi., p. 321.

who at the age of four had had some trouble necessitating the use of a catheter. At the age of seven there was some enlargement noticed of the left testicle. A week before applying for treatment he had been kicked in the testicle by a horse. An abscess had formed, and was incised, leaving a sinus. The testicle was then removed. The epididymis and part of the testicle were pushed up, and below was found a cyst containing hair, sebaceous matter, and a piece of bone (alveolar process), bearing one tooth.

Chondroma of the Testis.—The pathology of cartilaginous tumors of the testicle is one of the most unsettled of the questions relating to the growths affecting this organ. It is perfectly well known that some cartilaginous tumors present almost or quite nothing of a malignant character, either in their gross or microscopical characters or in their manner of growth and clinical course. On the other hand, cartilage plays so prominent a part in growths which are malignant in every sense of the term, and which resemble so much the chondro-sarcomas affecting the lachrymal, submaxillary, and parotid glands, that there is good reason for classifying them as malignant rather than as benign growths. If a surgeon inclines to the view of the benign character of these tumors, he is apt to be unpleasantly surprised by their pursuing a malignant course. If they are accepted as all being malignant or sarcomatous in nature, then one must admit that sarcomatous affections of this organ are often far more benign than are usually supposed. The possibility of a chondroma being a simple, benign, cartilaginous growth in an early stage, and then changing to a malignant one, by taking on or undergoing sarcomatous change, also suggests itself. Mr. Jacobson evidently considers this possible when he says that clinically it is extremely doubtful whether these apparently simple enchondromata of the testis may not at any time become sarcomatous; still, he does recognize a simple chondroma, and describes it under the head of pure uncombined enchondroma, including under this name those growths in which cartilage is the predominant, or the only, morbid tissue present. Mr. Eve also apparently does not believe that cartilage is an indication of malignancy. He has found it present in 12 out of 16 cases of what he terms cystic fibromata, and in 11 out of 16 cases of cystic sarcomata.

Mr. Butlin[1] makes the following plea in regard to chondromatous tumors: "In connection with the frequent combination of cartilage with spindle-celled tumors, let me try to rescue a group of tumors which I believe to be quite innocent from an opprobrium which most unjustly rests upon them. I mean the cartilaginous tumors of the testis." Such a strong statement from so able an authority demands careful consideration. To me it means that tumors, the bulk of which is composed of cartilage, pursue clinically a comparatively benign course, but it fails to convince me that they are not in their true nature sarcomas of a mild type.

Mr. J. Bland Sutton speaks, however, in no uncertain tones in reference to this question. In his recent valuable work on tumors he absolutely ignores the name chondroma as applied to testicular growths, and regards them as being simply chondrifying varieties of sarcoma. Kocher[2] likewise takes the same view, as he says in reference to prognosis that we must class testicular chondromata as malignant tumors

[1] Sarcoma and Carcinoma, p. 25. [2] Diseases of the Male Genital Organs, p. 502.

as much as we do sarcomata. Tumors of the testicle composed of cartilage only, not being associated with other growths, are very rare, if they exist at all. Who is to say whether the cartilage is embedded in a malignant or in a non-malignant matrix? The microscope will not always enable one to do it. In speaking of fibro-cystic tumors Mr. Eve says: "One class, however, is connected by such gradual transitions to the cystic fibromata on the one hand and the cystic sarcomata on the other, that sufficient data are not always present to allow of exact distinction." Again, he says: "There is no genetic difference between the innocent and malignant cystic tumors of the testicle: they are merely varieties of the same form of tumor." He gives as a diagnostic point that cartilage is less constantly present in the malignant than in the non-malignant growths, and says that in nearly all fibro-cystic tumors tortuous rods or nodules of cartilage are found embedded in the stroma, and yet Paget's famous case, one of the most malignant ever reported, presented these very characteristics. As yet we simply do not know positively as to the exact nature of the cartilage tumors. For the sake of convenience, those growths which do not return or give rise to metastases after removal are sometimes termed chondromata, and if they do return then they are sarcomata. I find it myself much easier to believe, with Mr. Sutton, that all cartilaginous tumors are in their true nature sarcomatous, and also that whether they pursue a benign or malignant course depends on circumstances about which as yet we know but little. There is a history of injury in many cases; this may, perhaps, serve to stimulate a growth to take a malignant course. The habits and occupation of the patient may also be the deciding point, and there are probably many other causes about which we cannot even form a surmise.

Clinically considered, the benign character of these tumors is so open to doubt, that in their removal all the precautions should be taken which are exercised when a growth is thought to be malignant.

Fibrous Tumor of the Testis.—This name is usually applied to those growths which start in the fibrous tissues in and around the testis. Poncet[1] describes such a case; it occurred in a man aged fifty-seven. In five months the growth had reached the size of a child's head. There were no adhesions to the scrotum. The patient had received a blow on the parts two years previously. Testicular feeling was present on the front part of the swelling. Castration was performed, and the growth is said to have been a pure fibroma which had for its point of origin the globus minor; it weighed two and a half pounds. In these cases the testicle is so closely associated with the growth as to make its removal necessary.

Lipoma of the Testis.—Roswell Park[2] published the report of a case of fatty tumor involving the testis and was unable to find the account of any similar one. It occurred in a man aged forty years, who had noticed a painless enlargement of the testicle for eighteen months. It was of the size of a cocoanut. The remains of the testicle were pushed upward. The tumor appeared solid, yet was soft and not tender. The skin was movable. The testicle was not merely embedded in the upper part of the mass, but was incorporated with the fat by apparently inti-

[1] Gazette des Hôpitaux, 14 Mai, 1887.
[2] Annals of Surgery, May, 1886, vol. iii., p. 365.

mate tissue connection. The cord seemed to enter the tumor and then pass into its substance for two inches before reaching the testicle. There was no hernia. On finding that the trabeculæ and blood-vessels radiating from the testicle into the fatty mass were so numerous and distinct, the whole mass was removed together. It weighed three pounds.

A case somewhat resembling the above was reported by Carl Koch.[1] It occurred in a man aged forty-nine years, who two years previously had noticed the growth commencing. In one year it had reached the size of a fist, and in two years had descended to the knees. It seemed to send a process into the inguinal canal. The testis was normal in size and was fixed to the under part of the tumor. The penis was concealed beneath the skin. The tumor and testicle were removed, and weighed ten pounds. The growth was composed of fat lobules and dense fibrous tissue, and arose apparently from the cord.

MALIGNANT DISEASES OF THE TESTICLE.—The pathology of malignant diseases of the testicle is involved in as much obscurity as is that of the more benign tumors. The clinical features of the growths which have been variously designated as sarcomata and carcinomata are essentially the same.

Scirrhous Carcinoma.—Such cases as the following sometimes occur, although but rarely. Inasmuch as they present a distinct clinical history, and distinct macroscopical and microscopical appearances, they may, for the present, be permitted to stand alone, as separate from the sarcomata. Rockwell[2] excised the testicle of a man aged thirty-five years. Two months previous to the operation the patient had noticed a hard nodule of the right testis. At the time of operating it was of the size of a large grape. There were burning, lancinating pains, which became continuous. The mass was stony hard and very sensitive to pressure, and a similar smaller nodule occupied the tail of the epididymis. There was no induration of the lymphatic glands, and the patient had never had any venereal disease. The testicle was excised and the tumor was diagnosed as scirrhus by Dr. Tieste, the pathologist to the hospital, as also by Dr. Hunt, the curator. The report states that the tumor was an irregularly shaped mass, and that there was no definite line of demarcation between the normal and diseased tissues. Superiorly, where the hardness was most marked, the growth was gritty on section by the knife, and presented the glistening white color with small yellowish spots characteristic of scirrhus. On microscopical examination well-formed connective tissue was found containing numerous blood-vessels. It was interesting to note the large number of cells and "cell nests," which were more numerous than is usual in cases of scirrhus. In a little over three months the patient returned with a similar tumor occupying the epididymis of the other testicle, which was also removed, and was found to be like in structure to the first. The patient, a year and two months after the second operation, was still free from the disease.

Sarcoma of the Testis.—With the possible exception of scirrhus, as above mentioned, all the malignant diseases of the testicle are of a sarcomatous nature. Lympho-sarcomata and myo-sarcomata have suffi-

[1] Deutsche Zeitschrift für Chirurgie, Bd. xxxii., Heft 3 und 4.
[2] Annals of Surgery, vol. viii., p. 446.

cient clinical or pathological peculiarities to justify them occupying separate classes. The remaining sarcomata, including what have usually been termed carcinomata, are noted for one great peculiarity, and that is their heterogeneousness of structure. This has been responsible for the many names which have been suggested for them. They are subject to changes and degenerations. Thus myxomatous changes affect the fibrous structures, sometimes to so great an extent as to cause these growths to be designated as myxomatous tumors when in reality they are sarcomatous. Cartilaginous changes occur, and they have then been termed chondromas. Mr. Sutton states that one-half of the sarcomas have cartilage developed in them. Mr. Eve found it in eleven out of sixteen cases of cystic sarcoma, and Mr. Butlin in eight out of thirteen cases of spindle-celled sarcoma and in one out of six of the mixed sarcomata.

For the sake of convenience, three kinds may be recognized: they are the round-celled, the spindle-celled, and the mixed varieties.

When the round-celled growth predominates it is termed a round-celled sarcoma. When the spindle-celled growth is most plentiful the tumor is designated accordingly. The mixed forms are made up most largely of those tumors in which the form of the cell is not distinct enough to entitle it to separate classification, or in which from the alveolar arrangement of the matrix a certain resemblance to carcinoma is present.

The general clinical characters of these tumors have already been sufficiently described by Mr. Bell under the heading of carcinoma and sarcoma, but a few peculiarities may be here noted. In their manifestations they are often widely different, some being hard and others soft, some rapid in growth and others slower, some large and others small.

The same relation of size and malignancy obtains here as exists elsewhere between the round-celled and spindle-celled varieties. The former are the more malignant and rapid in growth, and are more liable to cause metastatic deposits and to affect both testes, either simultaneously or at intervals. The spindle-celled variety is apt to be smaller, harder, and slower in growth, and is less likely to give rise to metastasis or to recur after removal. It usually attacks only a single testicle, and is very liable, as already mentioned, to be the subject of cartilaginous as well as of cystic, and sometimes of myxomatous changes.

The mixed variety embraces those cases in which the round-celled and spindle-celled elements are both prominent, and particularly those in which the more or less heterogeneous cells are included to a great extent in alveoli of more or less fully developed or embryonic fibroid tissue. It is this appearance and formation which has caused them to be called sarcoma alveolare and sarcoma carcinomatosum. The cells contained in the alveoli are not the typical epithelial cells of true carcinoma, but resemble more the lymphoid cells of a connective-tissue type, from which fact Dr. Formad [1] was induced to regard them as endothelial in origin and therefore sarcomatous in nature. He expressly stated his disbelief in the existence of a true carcinoma of the testicle, as well as of the ovary and kidney.

All these varieties of sarcoma are at times cystic. The cysts found in those that are undoubtedly malignant are lined with epithelium

[1] Trans. Path. Society of Philada., 1886, p. 223.

differing but little from that seen in the growths which, from their evidently more fibrous structure, are more benign in their character.

The mixed variety of sarcoma, from the fact of its marked alveolar arrangement, has often been considered a carcinoma and has been so designated. A common name for it has been medullary or encephaloid cancer.

Mr. Butlin apparently prefers to designate these growths as carcinomata, for his statistics include twenty cases of carcinoma and forty-one of sarcoma. He does not include scirrhus, not having seen any such. Mr. Jacobson also gives carcinoma a place in his nomenclature, and divides it into the scirrhous and encephaloid varieties. He further divides these latter into five sub-varieties, viz.: Cystic, which contain cysts lined with epithelium; reticulated, when the cells are fewer in number and arranged in a narrow meshwork; mixed, when the fibrous stroma, instead of forming alveoli, occasionally develops into cartilage, adipose tissue, and genuine bone; hæmatoid, when there is extreme richness of blood supply; and melanotic, only met with as a secondary growth.

It should be borne in mind that the question involved is principally one of nomenclature, and not one indicating different tumors. Mr. Sutton [1] says that "formerly it was the fashion to describe all malignant tumors of the testicle as cancer: of late years it has been ascertained that by far the greater number are sarcomata. . . . As to whether adenomata and cancers that caricature the secreting structure occur in the testicle, nothing definite is known. So far I have been unable to recognize such a specimen. . . . Malignant tumors of the testis require careful investigation, conducted on a full supply of material, accompanied by complete clinical histories." That is all he says on the subject, and he does not even state that there is such a growth as carcinoma of the testis.

I believe that all these malignant growths should be designated as sarcomata. There is no division line by means of which we can say that one kind is sarcoma and another carcinoma, and if there were two distinct forms I believe that we should be able to separate them.

The matrix varies from a round, embryonal-celled tissue to a more firm fibrous one, and that in the same tumor. The cells are heterogeneous and not of a pure epithelial type, but incline more to the endothelial or lymphoid type.

Prognosis.—This is not good. Kocher [2] concludes from a careful examination of the subject that death occurs about two years from the time at which the disease is first noticed. In seven cases that were operated on, and in which the retroperitoneal glands became affected, the average time at which death occurred was twenty-one months after the onset of the disease, and nearly eight months after operation.

Besides doubtful cases Kocher had the following six in which the time of survival after operation was ascertained. Two patients lived one year; one, one and a half years; one, four and a half years; one, eight and a half years; and one, ten and a half years. This gives an average duration of life after operation of four and a half years. In only one of these cases, however, was the growth a rapidly growing tumor

[1] Op. cit., p. 257.
[2] Die Krankheiten der männlichen Geschlechtsorgane, S. 487.

following after injury. The prognosis is best in those cases which develop slowly.

Mr. Jacobson[1] states that, as a rule, the retro-peritoneal glands and viscera will be involved by extension and secondary desposits within six month of the time of castration. Nevertheless, a useful life may be prolonged; the patient, rid of a wearisome encumbrance, is made more comfortable; and death is not accompanied by the same distress to both patient and friends as when the disease is seated externally.

Monod,[2] from a study of twenty-six cases of malignant disease in children, gives the time of death as from six months to a year.

Lympho-Sarcomata are different from ordinary sarcomata in that they resemble in microscopic structure enlarged lymphatic glands. They are very malignant, spreading rapidly and soon killing the patient. They occur most often in the young. The following example, however, occurred in a man aged seventy years.[3] A physician applied to Mr. Hutchinson to remove an enlarged testicle which he thought had been injured by bruising, as he was fond of hunting; there was, however, no history of definite traumatism. The testicle was enlarged to about the size of a hen's egg, and felt heavy and firm. It had been noticed for six months and was steadily increasing. On removal it appeared simply hypertrophied and hardened. The lobules and tubes were seen with remarkable distinctness, and on a larger scale than usual. On microscopic examination the growth appeared like, and was supposed to be, simple chronic inflammatory induration. In eighteen months after the operation, however, the patient returned with disease of the remaining testicle. It also was removed, being the size of a small fist. It exhibited a grayish-brown surface and was moderately firm in structure. Two years subsequently, he slipped in descending some steps, and soon afterward a growth appeared in the head of the tibia; spontaneous fracture occurred, and ultimately tumors developed in the subcutaneous tissue of several parts. He died about two and a half years after the second operation, and six years after the first. Mr. Parker and Dr. Shattock, who examined the testicle last removed, reported it to be a lympho-sarcoma. The structure of the new tissue was quite uniform, and of the most typical lymphoid kind. The reticulum between the individual cells of the growth was beautifully seen. There was nowhere the least indication of any transformation of the new substance into fibrous tissue, the cells of which substance are uniform in size and shape, and exhibit no enlargement, elongation, or other fibro-plastic changes.

Myo-Sarcoma.—This name has been given to those spindle-celled sarcomata in which the spindle cells have exhibited transverse striations. They are quite rare, and most of the cases have occurred in young children. In reference to *treatment*, it is well to bear in mind Mr. Butlin's advice, and risk an incision into an inflamed testicle rather than delay the removal of a malignant tumor.

Epithelioma of the Testis.—Epithelioma does not affect the testicle primarily, but may only involve it secondarily by extension from adjacent parts.

[1] Diseases of the Male Organs of Generation, p. 407.
[2] Le Progrès Médical, 1884.
[3] Trans. Path. Soc. Lond., vol. xl., p. 193.

Excision of the Testis.

The same precautions against sepsis should be observed in removal of the testicle that have already been detailed in considering the operation for varicocele. It is better to ligate the vessels of the cord separately than *en masse*, except, as stated by Kocher, when the tumor is so high as to render the cord inaccessible, or when there is an inguinal tumor. Mr. Harrison [1] says that when the whole cord is included in the ligature the pain is often severe and continuous. Precautions should be taken, particularly when the cord is divided high up, as it should be in malignant disease, that it shall not be drawn up out of reach when severed. It may be secured with hæmostatic forceps which are to be removed one at a time as the vessels are ligated. All bleeding is to be absolutely stopped, as otherwise extensive infiltration will occur, and necessitate the reopening of the wound. One hæmostat is allowed to remain until the wound is ready to be closed, so as to bring the cord again into view if the bleeding should recommence. If on account of the high division of the cord the surgeon wishes to have it readily accessible, then a loop of silkworm gut, silver, or silk may be passed through it and be allowed to remain until the next dressing.

There is a great tendency for the skin to become inverted and thereby delay healing. To guard against this it is wise to use the subcutaneous suture, or to pass some deep sutures a quarter of an inch or more from the edges. If these are of silkworm gut or silver (the latter now known to exert an antiseptic action in its neighborhood), they should be fastened to lead plates by means of clamped shot. If these plates are not used the skin swells around them and renders their removal painful and difficult. In lieu of the unabsorbable suture, catgut may be used. Four or five stitches should be passed through and then be brought back again and tied. The superficial wound may be closed with a continuous suture of catgut. A drainage-tube may be used if thought desirable, but should be removed on the day following the operation.

Spermatorrhœa.

When the conscience of a patient is once aroused concerning bad practices in which he may have indulged, he quite commonly goes to the other extreme and attributes far more serious results to them than they are actually responsible for. As this leads to a serious disturbance of his mental condition, and not unfrequently seriously hampers the physician in his treatment, it is well to bear in mind that so able a man as Sir James Paget has said,[2] in his lecture on sexual hypochondriasis, that he believes that one may teach positively that masturbation does neither more nor less harm than sexual intercourse practised with the same frequency in the same conditions of general health and age and circumstances.

Hyperæsthesia is a marked symptom, or perhaps cause of spermator-

[1] Diseases of the Male Urinary Organs, p. 561.
[2] Clinical Lectures and Essays, p. 291.

rhœa. To treat it S. W. Gross[1] recommended thirty grains of bromide of potassium, along with about ten drops of the fluid extract of gelsemium, every eight hours, and one-sixtieth of a grain of sulphate of atropine on retiring. If the bromide is badly borne it is to be given with three grains of quinine, or with ten grains of nitrate or bicarbonate of potassium, as recommended by Rosenthal. Mr. Reginald Harrison[2] advises astringent injections used for some time, and moderate doses of the extract of cannabis indica at bedtime. Locally, the passage of steel sounds is still considered to be of service, a moderate-sized instrument being used first and being followed by larger ones until the largest that the meatus will admit is employed. The Lallemand *porte-caustique* is not used as generally as injections made through the syringe-catheter of Thompson. Dr. F. R. Sturgis uses the endoscope, through which he makes applications to any desired spot in the deep urethra. Excision of the testicle for the cure of onanism, particularly in lunatics, has been tried, but Dr. Bell[3] said that, though he knew of one case in which benefit had resulted, yet in all the lunatic-hospital cases in which he had known of its performance no valuable results followed. In one hospital where it had been extensively tried no case of improvement had been observed, but in one instance a permanent and dangerous condition of irritability had ensued.

[1] Impotence and Sterility, and Allied Disorders of the Male Sexual Organs, p. 145.
[2] Op cit., p. 541.
[3] Boston Medical and Surgical Reporter, 1860, vol. lxi., p. 166.

OVARIAN AND UTERINE TUMORS.

BY

CHARLES B. PENROSE, M.D.,

PROFESSOR OF GYNÆCOLOGY IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE GYNÆCEAN HOSPITAL, PHILADELPHIA.

THE increase, during the last seven years, in our knowledge in regard to Ovarian and Uterine Tumors consists mainly in an improvement in the methods of dealing with those affections. Nothing of value has been added to our knowledge of the origin, causes, or pathology of tumors of the ovary and uterus. The treatment of ovarian tumors consists in their removal by cœliotomy as soon as they are recognized. Delay and watching the progress of the case are unwarranted, on account of the danger from the many accidents to which all abdominal tumors are liable. Among these dangers are septic infection, rupture, torsion of the pedicle, and adhesion to contiguous structures. The *technique* of the operation for ovarian and uterine tumors has been in some respects changed and improved during the last seven years.

ABDOMINAL OVARIOTOMY.

Abdominal ovariotomy is the operation to be performed in all cases. Preparatory treatment is always of great importance before cœliotomy. We should strive to have an aseptic abdominal surface, an aseptic vagina and cervical canal, and an empty gastro-intestinal tract. The best method to diminish the danger of infection from the gastro-intestinal tract is to empty it by free watery purgation. This is of advantage in case the intestine should be injured during the operation, an accident liable to occur in any case of intestinal adhesion; it renders all manipulations within the abdomen easier; and it very much diminishes the danger of infection through the bowel wall after the operation, an accident to be feared in case of post-operative arrest of peristalsis, from any cause. Asepsis of the vagina and cervix is important, because in any case it may be necessary to drain through the posterior vaginal fornix, and the operator may at the time of operation find that it is desirable to remove the uterus. The advantage of this step in addition to the removal of some forms of ovarian, tubal, and uterine tumors is receiving increasing recognition.

The following list of directions for the preparation of a woman for

the operation of cœliotomy is given to the nurses in the Hospital of the University of Pennsylvania:—

DIRECTIONS FOR THE PREPARATION AND CARE OF A WOMAN IN THE OPERATION OF CŒLIOTOMY.

Give a warm soap bath from head to feet once a day, preferably in the evening, from date of admission to the hospital.

Give a vaginal injection, night and morning, of one gallon of hot water (110° F.), followed by two quarts of a solution of bichloride of mercury (1–2000), from the date of admission. Introduce the nozzle of the syringe and one finger well into the vagina, inject forcibly, and depress the perineum.

The bowels must be moved at least once a day from the date of admission.

If necessary, give five grains of calomel at bed-time and follow by one drachm of Rochelle salt in a half tumbler of water one hour before breakfast.

The woman may have any diet until twenty-four hours before the operation.

Twenty-four hours before the operation, begin to empty the intestinal tract and regulate the diet.

Give one drachm of Rochelle salt, dissolved in one half tumbler of water or soda water, every hour until the bowels begin to move freely. Five or six doses are usually enough. Give light, easily digested, concentrated nourishment: milk, buttermilk, soft-boiled eggs, rare beef, soups, beef-tea, coffee, tea, and whiskey if necessary.

Give no food on the morning of operation unless the patient is very weak. In this case she may have a glass of milk, buttermilk, coffee, or milk punch. Give as little water as possible on the morning of the operation.

Three or four hours before operation give an enema of soapsuds and water.

When the bowels have been emptied, wash out the vagina with soap and water, using cotton and forceps. Cleanse carefully the vaginal fornices. Give a vaginal douche of one gallon of hot water and two quarts of bichloride solution (1–2000).

Then give a warm soap bath from head to feet. Scrub the abdomen from the ensiform cartilage to the pubes with a nail-brush. Cleanse thoroughly the folds of the umbilicus. Shave the pubes.

After this bath, put on the patient a clean undershirt and night-gown, and place her in a clean bed.

Then wash the abdomen from the ensiform cartilage to the pubes and from flank to flank, and the upper third of the anterior aspect of the thighs, first with turpentine, second with green soap, and finally with ether. Cover the abdomen with a large, wet bichloride dressing (1–2000). A large folded towel wrung out of a (1–2000) bichloride solution will answer this purpose. This is not removed until the patient is on the operating table.

One hour before the operation give a vaginal douche of two quarts of bichloride solution (1–2000), and introduce as far as the cervix a light vaginal tampon of gauze wet with (1–2000) bichloride solution.

Immediately before the administration of ether the bladder must be emptied, naturally or by the catheter.

As few nurses as possible should assist at the operation. Two are enough. Any nurse who is to have charge of the patient, or who assists in any way at the operation, must be thoroughly clean. She must take a hot soap bath on the morning of the operation and must be dressed in clean clothes throughout. She must not attend any other patient after she has dressed herself to assist at the operation. She must not be present at an autopsy, nor handle any anatomical specimen, nor dress a septic wound, nor attend any case of contagious disease during the forty-eight hours preceding the operation.

She must wash and disinfect her hands and arms, just as the surgeon; scrub with soap and water and a nail-brush; wash throughly in alcohol, and soak the hands in bichloride solution (1–1000).

After this cleansing she must touch nothing which has not been rendered aseptic. If she is obliged to touch anything which has not been sterilized she must wash her hands again. She must never touch instruments, sponges, or ligatures unless directed by the surgeon. She must never pick up anything which drops on the floor.

She must never allow a sponge or a gauze pad to be taken out of the operating room until the sponges and pads have been counted and the abdomen closed. For this reason discarded sponges and pads must be placed where they can be seen and counted; never thrown in the slop bucket.

The following instruments are necessary for the operation of cœliotomy for the removal of ovarian or uterine tumors:—

Hæmostatic forceps from 6 to 12, knife, scissors, pedicle-needles, trocar, cyst forceps, sponges or gauze pads, retractors, needles. Gauze pads made of convenient sizes are much preferable to sponges; the pads consist of 12 or 16 layers of gauze, lightly sewed together. They are cheap, and may be discarded after each operation. They can be perfectly sterilized by steam, and for this reason are safer than sponges.

The carbolic spray is no longer used in cœliotomy nor in any other branch of surgery. Solutions of bichloride of mercury should not be used on account of the absorbing power of the peritoneum. Some surgeons still use solutions of boric acid or salicylic acid. The best results may be obtained by using simple boiled or distilled water for washing sponges or pads, hands, and instruments, and for washing out the peritoneal cavity. On theoretical grounds some surgeons use a normal salt solution, a 0.6-per-cent solution of common salt, for washing the peritoneal cavity, believing that such a solution is less irritating to serous membranes than distilled water. The results obtained, however, are no better than those obtained with the latter agent.

Silk is the best material for ligature of the pedicle, and silkworm gut is a desirable suture for the abdominal wall. To guard against the occurrence of ventral hernia, the abdominal fascia should be sutured with a continuous, or an interrupted, silk or catgut suture.

The dressing is very simple, consisting of layers of dry sterilized gauze, covered with a pad of cotton, and retained with some form of abdominal binder. The dressings and gauze pads are best sterilized by steam, and the instruments by boiling in a solution of carbonate of sodium.

In the University Hospital the hands of surgeons, assistants, and nurses are sterilized by thorough scrubbing, first with hot water and soap; then with alcohol; and thirdly, with a 1–1000 solution of bichloride of mercury.

Drainage of Peritoneum.—The subject of drainage after cœliotomy is a very important one. All surgeons cannot have the same views on this subject, because the personal equation of the operator is an important element in the determination of the necessity of drainage in any given case. Neatness, asepsis, rapidity of operation, degree of traumatism inflicted on the abdominal structures, all depend upon the operator, and all are important in a consideration of the necessity for drainage. The old advice, "when in doubt drain," is good if we are confident that the drainage-tube will be properly watched after the operation. The drainage-tube removes excessive blood from the peritoneum, acts as a

hæmostatic, and tends to prevent general peritoneal infection after a dirty operation, or in case of escape into the peritoneum of the contents of a cyst. In case of rupture, the immediate microscopic examination of the cyst contents will inform us whether or not the contents are sterile, and will thus help us in determining the necessity for drainage. In the gynæcological clinic at the University Hospital the contents of all cysts or tumors which rupture in the abdomen during cœliotomy are immediately examined, and the subject of drainage is determined by the pathologist's report in regard to their sterility. It is found that large numbers of tubal and ovarian tumors contain a fluid resembling in all gross appearances real pus, and yet contain no organisms capable of exciting peritonitis. A valuable paper in this connection has been published by Schauta.[1]

The directions for the after-treatment of a woman upon whom there has been done the operation of cœliotomy, which are followed in the University and Gynæcean Hospitals of Philadelphia, are:—

No water or food is to be given to the patient for the first twenty-four hours after the operation. Women always suffer greatly with thirst after cœliotomy, but this can be relieved by wiping the lips and tongue with a wet napkin or with a piece of ice wrapped in a thin cloth.

Hot water or soda water may be given in small quantities, two teaspoonfuls every hour, and gradually increased, after the first twenty-four hours. Hot water is preferable to cold.

The patient must lie upon her back for the first forty-eight hours. She can be made more comfortable by slipping a folded sheet under the hollow of the back, or by drawing up the knees and placing a pillow under them. The patient should not move her body or draw up her legs herself; the nurse must do this for her.

The patient should be encouraged to pass her water voluntarily. If she cannot do so she should be catheterized about eight hours after the operation, using an aseptic soft rubber catheter, and cleansing the external meatus before passing the instrument. If necessary, the urine should be drawn every six or eight hours.

No food should be administered for the first forty-eight hours. At the end of this time the patient may have any easily digested food which she wishes, such as buttermilk, soup, beef tea, milk, milk and lime water, soft-boiled eggs, etc.

If there is no abdominal distention the bowels need not be moved until the third day after the operation. On the morning of the third day half a drachm of Rochelle salt should be given in half a glass of soda water every hour until the bowels are moved. This result may be hastened by an enema of soap and water administered as soon as the patient feels the inclination to have a movement.

If the Rochelle salt cannot be retained, one grain of calomel may be given in powder every hour for six or eight hours, and then followed by an enema.

Little or no nourishment should be given while administering the purgatives, since the combination may cause vomiting.

If a glass drainage-tube is used it must be cleaned by the nurse as often as the surgeon directs.

Every time before cleaning the tube the nurse must wash her hands with soap and water, and with bichloride solution (1–2000), as carefully as before the operation. The syringe must be washed inside and out with hot water and bichloride solution immediately before and after each cleaning of the tube. The syringe may be kept wrapped in a towel wet with bichloride solution. The rubber dam must be clean and dry. Fresh sterilized cotton must be placed over the mouth of the tube after each cleaning.

[1] Archiv für Gyn., No. 44, 1893.

Neglect of any of the details of asepsis in taking care of the drainage-tube is as fatal as neglect of such details at the time of operation.

If the patient is unable to pass flatus, the nurse may introduce into the anus the rectal nozzle of an ordinary syringe.

If the patient has distention, vomiting, and abdominal pain, a large, strong, hot mustard plaster may be applied over the epigastrium. If this fails to relieve the distention, a turpentine enema should be given (half an ounce of turpentine to a pint of warm water), and if necessary, this may be repeated in three or four hours. If the stomach is retentive, distention may often be relieved by the administration of half an ounce of sulphate of magnesium or of Rochelle salt.

The surgeon should never give opium in any form after cœliotomy.

The patient must not sit up in bed for any purpose during the first two weeks after the operation.

The sutures are removed about the tenth day. The incision must be firmly strapped with adhesive plaster. The abdominal bandage must always be neatly and firmly applied. The patient must wear an abdominal support of some kind for six months after the operation.

During convalescence the bowels must be moved daily, and daily vaginal douches must be given after the third day following the operation, if there is any vaginal discharge.

These directions are given in this rather dogmatic form because they have been drawn up for the use of nurses. They are of course not absolute, and modifications are necessary in certain cases.

UTERINE FIBROIDS.

Uterine fibroids do not cause death so directly and so quickly as ovarian cysts, but nevertheless they are dangerous growths. The statement sometimes made that a uterine fibroid rarely, if ever, causes death, is untrue: the advice to tide the woman over the period between the time of appearance of the fibroid and the menopause is pernicious, unless the tumor is of slow growth, exerts no pressure symptoms, and appears near the period of the menopause. In case of fibroid of the uterus the menopause is sometimes delayed for ten years after the usual time. Such cases are embarrassing to a physician who has perhaps promised the woman relief if she would wait until she should reach the usual period.

The menopause, moreover, does not always bring relief. Lennander[1] reports six cases in which the fibroid growth was not retarded by the production of an artificial menopause by removal of the ovaries. In one case a tumor weighing 58 pounds had developed seven years after that operation.

The cases are therefore exceptional in which it is proper to advise a woman with a uterine fibroid to await nature's cure at the menopause. Such are the cases in which the tumor is non-cystic, subperitoneal, of slow growth and creating no pressure symptoms, and not accompanied by hemorrhage. All such cases should be watched and operation urged as soon as the symptoms become more active. The reasons that immediate operation should be advised in most cases of uterine fibroid are: the menopause is delayed and does not promise certain relief; the menorrhagia and metrorrhagia resulting from the fibroid so dimin-

[1] Centralblatt für Gyn., No. 36, 1893.

ish the woman's resisting power that she is exposed to other disorders; the pressure of even small tumors obstructs the ureters and brings about secondary renal changes; an intra-ligamentous fibroid may be removable at an early period of its growth and afterward be irremovable; the woman is exposed to the dangers incident to abortion and obstructed labor; the presence of a fibroid condition of the uterus seems to render the woman more liable to the occurrence of malignant disease. In 205 cases of uterine fibroid analyzed by Martin, sarcomatous degeneration was found in six. The mortality at the present day is very small after the operation for uterine fibroid.

Old statistics in regard to *hysterectomy*, the most radical method of treatment proposed for the cure of uterine fibroids, are valueless for forming an opinion in regard to these cases. The most recent statistics show that (in skilled hands) the whole fibroid tumor may be removed with as little danger to life as attends the removal of an ovarian cyst. Consequently the element of mortality need not as formerly have weight in our determination as to the best course of treatment.

Chrobak[1] reports 38 unselected cases of operation for uterine fibroid. In 20 cases where total extirpation was done there was no death. In 18 cases where the uterus was amputated through the cervix and the stump treated intraperitoneally there was one death.

Rosthorn[2] reports 30 operations done during two years with one death. In all the cases the stump was treated intraperitoneally. Baer reports[3] 34 intraperitoneal operations with two deaths. I myself during a period of six months removed the uterus 20 times, consecutively, by cœliotomy, with no deaths, the pedicle being treated intraperitoneally.

The *electrical treatment* of uterine fibroids does not stand the test of time. It has been employed enthusiastically by many surgeons opposed to the use of the knife, only to be dropped after a fruitless trial. The electrical treatment does not cure the disease; it delays more useful treatment; it has caused severe pelvic inflammation; and it has resulted in death.[4] Cutter had four deaths in his first fifty cases.[5] *Medical treatment* relieves the symptoms but is not curative in cases of fibroid tumor of the uterus. The only means of cure is through an operation, and the methods which experience has proved to be useful are *removal of the Fallopian tubes and ovaries*—to arrest menstruation, to arrest the functional activity and growth of the uterus, and ultimately to cause its atrophy—and the operation of *hysterectomy*, or removal of the uterus with the attached growths.

REMOVAL OF TUBES AND OVARIES.—The operation of *castration* is especially applicable to fibroid tumors occurring in young women, or in the early stage of any fibroid tumor. It is also most desirable as an early operation in fibroid tumors which have become or are becoming intraligamentous. For these tumors produce the most disastrous results by pressure, and from the position which they occupy in the pelvis they are exceedingly difficult to remove by any surgical operation. Therefore, the stoppage of their growth at an early stage is to be desired. All varieties of fibroid tumor have been cured by this opera-

[1] Centralblatt für Gyn., No. 20, 1893.
[2] Wien. klin. Woch., Nos. 41 und 42, 1893.
[3] Trans. Am. Gyn. Soc., 1893.
[4] Journ. Electro-Therap., June, 1888, p. 170.
[5] Pozzi, Med. and Surg. Gynæcology, vol. i., p. 251.

tion, but it seems to be followed by less favorable results in the fibro-cystic and soft œdematous growths than in others.

In any operation for the removal of the uterine appendages for the cure of uterine fibroid, the surgeon should be prepared to remove the whole tumor or even to do a supra-vaginal hysterectomy, since he may find that the lesser operation is impracticable.

The operation of castration is not applicable to the following cases: intraligamentous tumors which are producing urgent pressure symptoms; very large tumors; fibro-cystic tumors; and teleangeiectatic tumors. Complete removal of the uterus is, moreover, an operation now attended with such a small mortality that it is often preferred to castration, the beneficial results of which do not appear so promptly.

SUPRA-VAGINAL HYSTERECTOMY.—The operation of supra-vaginal hysterectomy has passed through several stages in its evolution toward the state of surgical perfection which it has now attained. Discussion on this subject has been in regard to the treatment of the stump or pedicle: one school of surgeons urging the use of the clamp or *nœud;* and the other advocating the intraperitoneal treatment, or dropping the stump after hæmostasis has been secured, and closure of the abdomen. The discussion is similar to that which took place in regard to the treatment of the pedicle in ovariotomy. The extraperitoneal treatment of the stump has had its day. From a surgical point of view it is far from ideal; and, as the statistics of the intraperitoneal method are now even better than those of the extraperitoneal, no valid argument can be brought forward for continuing the use of the latter.

Bantock, an able advocate of the extraperitoneal method of treating the pedicle, has a mortality of a little under 15 per cent.[1] Some statistics have been already given (Chrobak, Rosthorn, Baer) which show that the uterus can be removed and the abdomen closed with a mortality under 4 per cent.

Martin's statistics[2] are of interest in a comparison of the two methods. He reports 97 operations, in 43 of which the stump was treated extraperitoneally, with a mortality of 30.2 per cent., while in 54 where the intraperitonetal method of Chrobak was followed, the mortality was 9.5 per cent.

In the method of operating, as developed by Chrobak and other surgeons, no uterine tissue is included in the ligatures. The ovarian and the uterine arteries are ligated, and after all the blood supply has thus been cut off from the uterus, this organ is removed. There is no more danger of hemorrhage after doing this than there is when a vessel is ligated in any other surgical operation.

The essential steps of this operation are as follows. Slight modifications have been made according to the taste of individual operators.

The ovarian artery is ligated on each side by a ligature passed through the infundibulo-pelvic ligament. A second ligature is placed nearer the uterus on each side to control bleeding from the uterine end of the ovarian vessels. The broad ligament is then divided immediately inside of the first ligatures. The peritoneum is incised around the cervix immediately above the reflection from the bladder. The

[1] British Gyn. Journal, May, 1893, p. 83.
[2] Centralblatt für Gyn., No. 20, 1893.

bladder is dissected from the cervix as low as the junction of cervix and vagina. The uterine vessels—the pulsations of which may usually be felt—are then ligated. The ligature is passed either between the folds of the broad ligaments, or outside of them, according to their thickness and vascularity. The uterus may then be amputated at any point in the cervix, or may be removed at the utero-vaginal junction. The stump and the peritoneum may be closed with sutures. Drainage is not necessary. When the cervical canal is opened it may be rendered aseptic with the actual cautery, or with a 1–500 solution of bichloride of mercury.

Cancer of the Uterus.

Complete removal of the uterus is becoming more widely recognized as the best operation in cancer of the cervix or body of that organ. It is the operation which should always be advised in any case where the disease has not extended too far to admit of complete removal of all infiltrated tissue.

The cancerous uterus has been removed by cœliotomy, by vaginal hysterectomy, and by the combined method. Goodell[1] states that statistics warrant the assertion that the remote or permanent success of the operation of vaginal hysterectomy far exceeds that of all operations undertaken for cancer in all other parts of the body.

The remarkable statistics of the Dresden Clinic confirm this favorable view.[2] Leisse presents a tabulated statement of the histories of all the patients as far as they could be obtained. Of 80 patients examined over two years after the operation, 45 or 56.2 per cent. were free from recurrence. Of 58 patients examined three years after the operation, 58.6 per cent. were free from recurrence. Of 42 patients examined after four years, 59.5 per cent were free from recurrence. Of 30 patients examined after five years, 60 per cent. were free from recurrence.

Leopold[3] states that of 76 of his patients remaining under observation after recovery from the operation, 72 had no recurrence of the disease from one to five and a half years subsequently.

Early diagnosis in uterine cancer is essential for successful treatment. The first appreciable manifestation of the disease is irregular or unusual bleeding from the vagina. This bleeding may be very small in amount. It may appear as menorrhagia, as a slight show of blood between menstrual periods, or as a slight bleeding, often with more or less periodicity, occurring some months or years after the menopause. Such unusual bleeding in a woman over thirty-five years of age should always arouse suspicion. It demands an immediate careful vaginal examination, supplemented in case of any doubt by microscopic inspection of the cervical or other suspected tissue. Goodell's papers on Vaginal Hysterectomy are valuable in this connection.[4]

[1] Med. News, Dec. 10, 1892. [2] Archiv für Gyn., Band xl., Heft 2, 1891.
[3] Quoted by Goodell, Med. News, Dec. 5, 1891.
[4] Med. News, Dec. 5, 1891, and Dec. 10, 1892.

THE PROGRESS

OF THE

CÆSAREAN AND PORRO-CÆSAREAN OPERATIONS AND THE REVIVAL OF SYMPHYSEOTOMY.

BY

ROBERT P. HARRIS, A.M., M.D.,

OF PHILADELPHIA.

THE CÆSAREAN OPERATION; PUERPERAL CŒLIO-HYSTEROTOMY.

THIS operation has in a very remarkable degree demonstrated, during the past seven years, and especially in Leipsic, Dresden, Vienna, and Glasgow, the fact that it is capable of being made one of a very minimum measure of fatality to both mothers and children, when performed early in labor, or before it, and with all the precautions which experience has shown are essential to success, in avoiding peritonitis, hæmorrhage, septic infection, and nerve-shock. Those who have most carefully studied the whole history of the operation have much less fear of its result in death than the general practitioner, who, as a rule, is strongly prejudiced against it, and only helps, by his fears, to produce the greatest element of danger, viz.: a delay in the use of the knife. Had the operators of our country entire control, from the onset of labor, of every parturient woman whose case is such as to render a Cæsarean section a possible necessity, and could they also command consent of the patient and her family to the use of the knife at the proper moment, we should, in time, produce a record far more to our credit than the one which we now have, and which, as a careful collector of cases, I have recently been led to feel is, in a measure, almost a disgrace; not to the operators, as a rule, but to those having the early conduct of the labors. Could the dangerous element of fear of the operation be changed into a fear of the consequences of delay in operating, we should soon be able to present for the United States a much more creditable record of results.

So intimately is the prognosis of any given case connected with its history prior to the operation, that we are able to state with considerable accuracy what has been the result to the mother, when we learn

her *age, cause of difficulty, number of hours in labor, the attempts made to deliver, and the condition presented by her when the section was commenced.* The necessity for this operation is largely produced by poverty, in its deforming influence upon the development and growth of the pelvis; and the subjects of it are very rarely such as live in comfortable circumstances, as to house, ventilation, and diet. When this country was young and sparsely settled, it was held that Cæsarean women were much more likely to get well in their own homes than if treated in a hospital; and the results at that time appear to have warranted men in holding that opinion. But now the hospital has many advantages over the abodes of poverty, and patients, for a number of reasons, have a better prospect of recovery, particularly when they have entered the hospital prior to the access of labor. Great changes have been effected in hospital construction and ventilation, and in the aseptic management of surgical cases; so that patients are now safer in hospital than they were formerly at their own homes. It was generally thought, until recently, and is still held by some, that the Cæsarean section should not be performed until after the commencement of labor; but the results of Cæsarean horn-rips, in women advanced in pregnancy, have demonstrated that it is not an essential of success, or safety, that the patient shall have been in labor prior to the use of the knife. When the uterus is torn open, or incised, in a woman advanced in pregnancy, it is a very rare and exceptional case for the uterus not to be excited to immediate contraction. As 10 women and 7 children have been saved after 14 Cæsarean horn-rips, it is not to be claimed that the Cæsarean operation is increased in danger by being performed prior to the commencement of labor; on the contrary, the experience in the United States of recent years teaches that an operation before labor is far safer than one performed after uterine contractions have been long in action. It has been well established that uterine inertia is a product of muscular fatigue, and that to secure a continued contraction after delivery, the muscular power of the organ should not have failed through overwork. We are also to consider the fact that women who require Cæsarean delivery are often dwarfs in height and development, and readily become exhausted under the futile efforts of the uterus to expel its contents; and we are also to bear in mind that peritonitis is an adynamic disease in many parturient women, and that its production is favored by a condition of physical exhaustion.

The greatest step that has ever been made in diminishing the proportion of deaths in women delivered under the Cæsarean section, was the introduction of multiple suturing of the uterine wound, and particularly the universal adoption of the closure of this incision by sewing its edges together. This wound has been secured by sutures, occasionally, during more than a hundred years, and the step was for a long period very forcibly condemned and regarded as dangerous. By slow degrees it grew into favor and became, about thirteen years ago, the general practice of operators. Since 1882, under the teachings of Dr. Sänger of Leipsic, and others in Germany, the employment of many deep and superficial sutures of carbolized silk has been advocated, in order that the individual tension upon the stitches may be reduced. There is a disposition on the part of certain operators to break away from this plan, and to employ only deep sutures and not many of them; but the

safest work of the world has been accomplished by the deep and superficial suturing, 10 or 12 stitches in each row being sufficient to accomplish the purposes of the method. Where the operation is performed before labor, or where labor has existed but a very short time, multiple suturing may not be required; but it is safer to secure the wound against the danger of post-partum relaxation and leakage.

The possibilities of Cæsarean delivery in saving mothers and children are most encouragingly demonstrated by the operations in the cities of Leipsic and Dresden, where the mortality in 100 cases has been 7 women and 3 children. The record of Leipsic up to August, 1893, was 55 operations—3 women and 3 children lost. The fatal cases were, in order, Nos. 10, 28, and 37. Prof. Max Sänger saved all of his thirteen patients, and all of their children but the first, which had been some time dead. The Dresden record is to July 25, 1893, and comprises 45 cases with 4 deaths, all of the children being delivered alive. It begins with May 25, 1882. Patient No. 4 died on the fifth day of peritonitis; No. 15 on the third day of œdema of the lungs; No. 27 on the fifth day; and No. 34 on the fourth day, the latter of general peritonitis and œdema of the lungs.

Prof. Schauta's Clinic of the General Hospital of Vienna, from Nov. 7, 1889, to July 25, 1893, gives a record of 30 Cæsarean deliveries, with 4 women lost and all of the children delivered alive. Patient No. 9 died of marasmus and bronchitis; No. 15 of eclampsia; No. 18 of endometritis and peritonitis, after "castration for osteomalacia;" and No. 26 of ileus, after her second Cæsarean delivery.

Dr. Murdoch Cameron, of Glasgow, reported 30 Cæsarean operations performed by himself, up to July 6, 1893, with 27 recoveries.

Here we have collectively, from three countries and four localities, 160 Cæsarean operations, by a number of obstetric surgeons, with 14 deaths of women, or less than 9 per cent. There were eight operators in charge of the cases in both Leipsic and Vienna, and they averaged one death in twelve.

We have a very different picture to present from the Cæsarean record of the United States. Some time ago we felt encouraged by the results of American work, as it appeared from the table in hand; but very recent private communications have materially altered the percentage of women saved. Our large cities, and particularly their maternity hospitals, are reducing their rate of death; but the same cannot be said for the results in private practice, where many women are brought under the knife in an unfavorable condition, and must almost necessarily die. During the eleven years following the introduction of the Sänger method and its modifications, in October, 1882, there were 88 operations in the United States, with a loss of 35 women and 16 children. In the years 1890–'91–'92 and '93, there were 50 of these operations, with 14 women, or 28 per cent., and 10 children, or 20 per cent., lost. In the maximum year, 1890, there were 17 operations, with a loss of 4 women and 1 child. In the next 22 months, up to Nov. 1, 1893, there were 22 operations, with 6 women and 5 children lost, a mortality for the women of $27\frac{3}{11}$ per cent. We may rate our present mortality at about 28 per cent., which is far higher than it ought to be, and would be, if the women were all operated upon in proper season. The fatality of the operation largely depends upon the condition

of the woman at the time it is performed, and in a measure, also, upon what prior attempts have been made to deliver her. The promising cases are those of patients not yet in labor, or in it only two or three hours; and where there have been no attempts to deliver through the pelvis.

THE PORRO-CÆSAREAN OPERATION; PUERPERAL CŒLIO-HYSTERECTOMY.

This operation has had a very thorough trial upon several hundred patients, and in twenty-one different countries. It is now being performed about 50 times each year, and the mortality under it in the years 1890 and 1891 was 14 per cent. for the women and 29 per cent. for the children. This is an unusual death-rate for the latter, as shown by the 100 cases of the years 1884, 1885, and 1886, collectively, when only 15 children were lost, although 42 women died. There has been a gradual diminution in the rate of mortality for the women during the nineteen years of its performance; for out of the first 40 cases there were 21 deaths.

When this exsective operation was introduced by the Pavian professor in 1876, its design was to reduce the fearful rate of death that followed the old Cæsarean section in Italy, by changing the intra-abdominal wound of the uterus into an extra-abdominal one that should be free from the danger of leakage of any kind into the peritoneal cavity. This it in a measure secured; but the introduction of the antiseptic technique of 1880, with its system of multiple suturing of the uterine incision, accomplished much more, and did not have the objectionable features of rendering the woman sterile; of drawing in her abdomen above the bladder; and of the slow closure of a granulating wound. Many obstetricians object to the Porro method in the cases of married women, and prefer the conservative mode of operation which has been so successfully and frequently performed in Germany. And besides, if desirable in any case, the woman may be rendered sterile with less risk by ligating her Fallopian tubes.

The Porro-Cæsarean operation is to be preferred where the subject has osteomalacia, has decided threatenings of septic endometritis, or has a fibroid tumor of the uterus that should be removed by exsection. By the subperitoneal method of securing the stump, there has been a reduction of mortality to 12 per cent., and some of the objectionable features of the extraperitoneal method have been removed. The exsective Cæsarean operations of the United States have saved 18 out of 29 women, while of 29 children 9 have been lost. As this operation has repeatedly cured osteomalacia, it should always be selected when that affection is present.

SYMPHYSEOTOMY; DIVISION OF THE SYMPHYSIS PUBIS.

This operation has been so repeatedly described in an historical sense that I shall avoid examining its early record, except in so far as very recent investigations make it desirable.

This method of delivery, by enlarging the calibre of the pelvis, dates

back to the year 1777; and its life has been by common consent divided into three more or less active and successful periods. The first period extends from 1777 to 1860 inclusive; the second from 1865 to 1885 inclusive; and the third from 1886 to the present time. A careful study of the progress of the operation and its varying degrees of success will show why these periodical divisions have been thought desirable.

The First Period.—The record of the eighty-four years of this period has been repeatedly hunted up, and particularly so within the last twelve years, since it became evident that antiseptic measures were about to work a revolution in the results of the operation. I thought I had done well in 1883 to search out 70 cases and report them chronologically; but the combined investigations of Morisani of Naples, Franz L. Neugebauer of Warsaw, and myself, since that date, and particularly in 1892 and 1893, have made it evident that the 84 years should be credited with at least 150 cases, the results of many of which are not upon record. We have, however, dug out of the obscurity of the past 114 operations, of which 72 ended more or less favorably; at least the women did not die, although many suffered from various discomforts, while 41 children are enumerated as having been saved and 72 lost. This method of delivery grew rapidly into favor for experimental practice, and again lost favor, when its results became known. In its first year there was, as far as we now know, 1 operation; in its second there were 16; and 16 collectively in the next four years. Six women lost out of 16, and 12 children, in 1778, put at once a check upon its favorable reception; and its enthusiastic laudation on the part of Sigault and Leroy failed of the desired effect: 40 per cent. of deaths for the mothers and 75 per cent. for the children was not what had been anticipated. Under the first 50 operations, 17 women and 32 children, or 34 and 64 per cent., respectively, were lost. This period closed with the year 1860, and the number of operations year by year diminished until the average was not even one per annum.

The Second Period began in 1865, after there had not been a symphyseotomy performed in any part of the world during five years. There had been only one case in Great Britain during the first period, and not one in the United States. In the second period (1865–1885 inclusive) the operation was confined to Italy with two exceptions, where it was done in the United States, and of the 75 cases, 71 belonged to Naples. The revived operation *in Naples* began in 1866, and was carried on with few exceptions by Profs. Ottavio Morisani and Raffaele Novi, who reintroduced it after an interval of seven and one-half years (July 25, 1858, to January 5, 1866). By great care in the management of their cases the Neapolitan operators managed to save 40 women and 41 children as the result of their first 50 operations, and to avoid the production of any pelvic lesions as sequelæ of delivery. All of the 50 women had been the subjects of rickets, and about three out of four of them were delivered without the aid of forceps. Version was only resorted to in cases of transverse position. The pubic sections all were made from within outward and below upward, by the probe-pointed and sickle-shaped bistoury of Galbiati. Of the whole 75 operations of the second period 21 were fatal, and 17 children were lost.

The Third Period began with January, 1886, and the operations

were with one exception, which was in the United States in 1889, confined to Italy, until February 4, 1892, when the results in Naples had so highly recommended this method of delivery that it was again introduced into Paris by Prof. Adolphe Pinard.

With 1886 commenced a new era in symphyseotomy in Italy, as is shown by a marvellously low rate of death, for both women and children, amounting to a loss of 2 out of 50 of the former, and 6 out of 50 of the latter. The two women lost were after very long labors, one of them of four days; one prematurely born child died; one died from prolapsed cord; a third, born asphyxiated, lived twelve hours; a fourth lived one day; and the two others were stillborn, one after a labor of 84 hours. The success attained in Italy is largely due to the care and experience of Profs. Morisani and Novi, of Naples, who have now been operating for twenty-nine years, and American operators have shown their wisdom by following very generally what may properly be called the Italian method, since although not original in Italy, it was improved and perfected by Prof. Ottavio Morisani.

The instruments required for the *sub-osseous method* of division, in which the symphysis is divided from within outward and from below upward, are a scalpel, a strong, probe-pointed, sickle-shaped bistoury, some hæmostatic forceps, a needle-holder and needles, a metallic catheter, ligature silk, gauze, cotton, and a pelvic bandage. After these have been sterilized, the woman to be delivered should be placed upon her back with her knees drawn up and separated; the mons veneris and labia majora are shaved, and the suprapubic region, vulva, perineum, and vulvo-vaginal canal are disinfected. The operator should then examine the depth, thickness, and direction of the symphysis, and should search out the fossa in its superior edge which marks the point of union of the two pubic bones, then examining their inferior margin and their anterior and posterior faces. It should be borne in mind that the pubic junction is in some cases as deep as three inches, and that it may be found illineal, and in rare instances, ossified. The saw is a dangerous instrument to use, as it is difficult to sterilize, and death from sepsis has followed its employment; a new instrument may be provided in a case where anchylosis is at all probable.

The Italian Operation as now Performed.—The position of the operator may be between the legs of the patient, or at her right side, as he may prefer. Prof. Morisani stands between the extremities and operates through a very small incision, an inch or a little more, having very small hands.

The female catheter is introduced and given into the hand of an assistant, that he may depress the urethra from the pubic arch, and at the same time carry it to the right side, to save it from injury. A longitudinal incision is then made through the skin and fat above the symphysis, about an inch and a half by two inches in length, ending about three-quarters of an inch above the pubis, and passing in a line down to the insertion of the recti muscles. The length of the incision required will depend much upon the thickness of fat to be cut through. Detaching for a short space the recti muscles from their attachments to the two pubic bones, the left index finger is introduced into the opening and made to separate the retro-pubic tissues. Then the palmar face of the finger is applied directly to the posterior surface of the symphysis, and

fixed against the inferior margin of the articulation, while the assistant attends to the catheter as stated. The operator then introduces the symphyseotomy bistoury and hooks it around the articulation, cutting the interosseous ligaments and cartilage from within outward and from below upward. When the section has been completed it will be known by a creaking sensation and by a separation of the bones for from 1¼ to 1½ inches. The wound is now covered with gauze dipped in a bichloride solution of 1–1000, and the operator attends to the delivery of the fœtus, having at the same time the separation of the innominata antagonized by pressure with the hands of assistants. During the passage of the head he ascertains the amount of pubic separation, sprays the vagina, and, when the placenta is delivered, introduces six or more interrupted silk sutures into the edges of the wound; then dresses it with sublimated cotton, 1–2000, and bandages the pelvis and lower extremities.

It should be borne in mind that there is no necessity for hurrying the fœtus into the world, and that its delivery by the forceps may be accomplished safely, or with extensive lacerations of vagina and perineum, under a slow or rapid traction, respectively; and this caution is especially applicable to the cases of primiparæ, who constitute a large proportion of the women to be operated upon, there having been 16 such out of 30 in the United States.

The experience of American symphyseotomists, as well as those of Italy, has shown that there is no occasion to unite the pubic bones under any plan of restraint other than that afforded by external bandaging or by a pelvic corset. The German plan of wiring the bones together keeps up the temperature of the patient, and the French method of passing stitches through the ligamentous tissues on either side of the symphysis, cannot be made use of where the direct incision of Sigault is not employed. Fixation of the pelvis by external support brings the pubic bones together, and the joint becomes firm, as a rule, in from two to four weeks.

Spread of the Operation in 1892.—The fact that the Italians had saved 36 out of 38 women, and as many children, from January, 1886, to February, 1892, induced Professor Pinard to make a trial of symphyseotomy in Paris, and to advocate its general adoption as a substitute for craniotomy. It had only been performed once in France since 1833, but its reintroduction at once gave it an impetus that caused it to extend to ten other countries before the close of the year. There were 12 operations in Italy in 1891, and 85 in twelve countries in 1892, of which Italy had 11. Of the 74 cases not in Italy, France had 37 with 6 deaths; Germany 13, with 2 deaths; the United States 7, with no death; Russia 4, 1 lost; Austria 6, no death; Ireland 1, saved; Switzerland 1, saved; Canada 1, saved; Brazil 2, saved; India 1, and Holland 1, lost. The maternal mortality for the year in Italy was 0, and elsewhere 13½ per cent.—not a very encouraging record for the rest of the world with its inexperience.

The record of 1893 shows a remarkable increase in the number of operations in Europe and America, there having been more in the first six months than in the previous year. The death-rate of the women still remained high: 14 in 95, while that of the children was reduced to 12 in 95.

The American record amounts to 90 operations in 15 years. The United States has had 82, with 10 women lost. Canada has had 5 operations, and Brazil 3; no women or children lost. Our mortality thus far has been 12½ per cent. in the United States. France lost 1 woman and 3 children in six months of 1893 under 16 operations, thus very materially reducing her death-rate. Professor Pinard lost his ninth and seventeenth patients, which were the first to die under his care. The operation is now well thought of in Paris, as success has largely removed the old prejudice against it.

Pinard had	25 operations.	Lost 9th and 17th mothers.	Lost 18th child.
Varnier "	9 "	.....	" 7th "
Wallich "	7 "	Lost 6th mother.	" 4th "
Lepage "	4 "	.....	.....
Bouffe "	2 "	Lost 1st mother.	.....
Potoki "	1 "	.....	Lost 1st child.
Aggregate	48 operations.	4 mothers died.	4 children died.

INJURIES AND DISEASES OF THE FEMALE GENITALS.

BY

THEOPHILUS PARVIN, M.D., LL.D.,

PROFESSOR OF OBSTETRICS AND DISEASES OF WOMEN AND CHILDREN IN THE JEFFERSON MEDICAL COLLEGE, PHILADELPHIA.

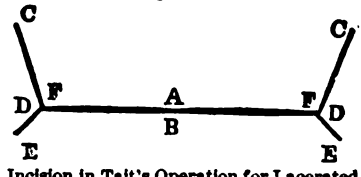
In these pages will first be presented some operations for restoration of the perineum and for colporrhaphia, which were not given in my former article; perineotomy in the female will also be briefly described.

The methods of operating for ruptured perineum are in recent years very many, at least in name, but I shall consider only Tait's, Winckel's, Martin's, and Sänger's.

Lawson Tait's Operation for Partial Rupture of the Perineum.

The patient—rectum and bladder having been recently emptied—lies upon her back, is anæsthetized, and the lower limbs are held strongly flexed upon the abdomen; it is well to have an antiseptic plug of cotton, with string attached to it, passed into the rectum. The operator has from three to five silkworm-gut sutures, a strong, curved needle with handle, and a pair of short, thick scissors, the blades of which make an obtuse angle with the handles.

Fig. 1761.



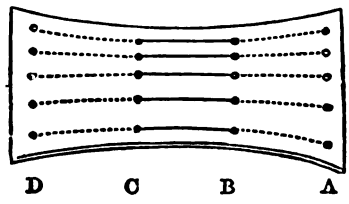
Incision in Tait's Operation for Lacerated Perineum. (Macnaughton Jones.)

Two assistants, with thumb or index finger, one on each side, render the tissues tense at a point corresponding with a median transverse line crossing the perineum between the anal and vulval openings. The operator introduces the index and the medius into the lower portion of the rectum, and then thrusts one point of the scissors through the skin thus stretched, cutting the tissues from side to side: the incision is about three-eighths of an inch deep, and a rectal and a vaginal flap are thus formed. Next two incisions are made, each a third of an inch long, posteriorly and obliquely from each end of the transverse cut; similar incisions are made anteriorly, an inch in length, into the tissue of each labium. The subjoined illustration

shows the transverse and the anterior and posterior incisions.[1] (Fig. 1761.)

"The vaginal flap A is held upward, and the rectal flap B is turned downward, the angles A F C being pulled by forceps diagonally upward and inward toward the middle line, and the angles B D E being pulled downward and forward. The lines C E thus become straight, and the wound takes this form (Fig. 1762)—

Fig. 1762.



Tait's Operation for Lacerated Perineum, Showing Points of Entrance and Emergence of Sutures. (Macnaughton Jones.)

"By means of a stout-handled and well-curved needle the silkworm-gut sutures are entered on one side about an eighth of an inch within the margin of the wound (so as not to include the skin) at the dots A. They are buried deeply in the tissue as far as B, and then the needle is made to emerge so as to miss the angle of the wound. The needle again enters at the large dots C and emerges at the dots B. By thus missing the upper or deep angle of the wound between B and C, the two great and divided masses of the old perineum, which lie in the parallelograms respectively bounded by the lines of large dots A—B and C—D, are accurately adapted. The rectal and vaginal flaps respectively point into the rectum and vagina, and like an old-fashioned flap-valve prevent noxious material entering the wound. The resulting mass of perineum is amazingly large, and union is almost inevitable. . . . The resulting cicatrix is absolutely linear, and so resembles the natural raphe that in three or four months after the operation it is quite impossible to determine from the appearance of the parts that the perineum has ever been injured, for there are no stitch-hole marks left to tell the story. The pain experienced after the operation is trifling compared to the old method of quilled or shotted suture." The stitches are left in for three or four weeks, and great care is taken that the rectum and vagina are washed out twice daily.

Many operators depart from Mr. Tait's rule not to include either margin of skin in the sutures, claiming that by such inclusion the stitches hold more firmly, and that closer approximation is secured: so too, some do not hesitate, though operating as suggested, to remove the stitches at the end of ten or twelve days.

This operation is very easily and quickly done—only eight or ten minutes being necessary—and when applied to suitable cases gives very satisfactory results, and does not merit the disparagement which some have cast upon it. Its value has, among many others, been freely recognized by some of the most able German operators, Gusserow and Winter, for example.[2]

Many of the illustrations and descriptions given of Tait's operation are misleading; for example, some of the former do not show the posterior incisions, but only the transverse and anterior, and others represent the sutures as buried in their entire course; several writers state

[1] The figures and the description are Mr. Tait's, as given in Macnaughton Jones's Manual of Diseases of Women.

[2] Deutsche med. Wochenschrift, 1892.

that silver sutures are employed, when really silkworm gut is the proper material.

The following illustrations from Pozzi's work will assist in understand-

Fig. 1763.

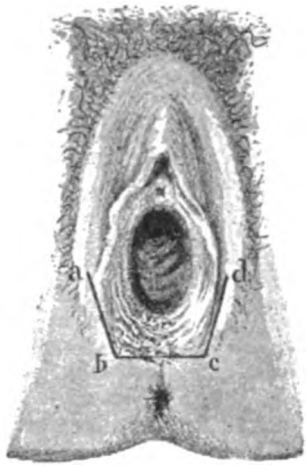
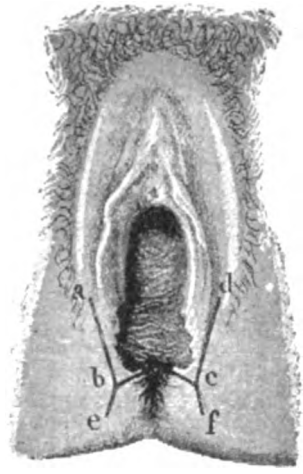


Fig. 1764.



Tait's Operation for Lacerated Perineum. (Pozzi.)

ing the method, and also will assist in showing the omissions and errors that have been mentioned. (Figs. 1763, 1764.)

ANTERIOR COLPORRHAPHIA.

Under this head the only recent operation that will be presented is Winckel's.

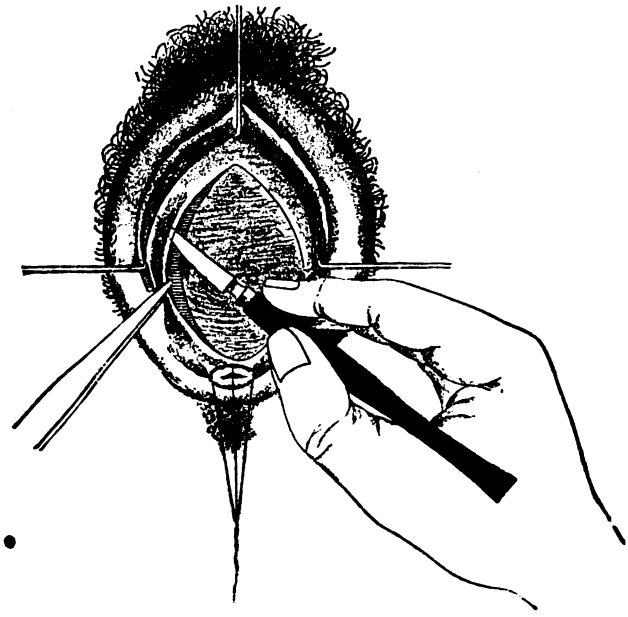
Professor Winckel,[1] in giving his reasons for dissatisfaction with the old methods, remarks that the vesico-vaginal septum becomes thinner in the aged from decrease of fatty tissue, and that, as we cut out a large piece from the anterior vaginal wall, and stretch the lateral parts over this denuded portion, we do not increase the thickness, but make the wall less resistant; he has seen too, after Sims's operation, obstinate vesical disease in a patient, possibly from some of the stitches having penetrated the bladder. He has been led therefore to devise a new method, against which such objections cannot be made. This method is as follows: A sufficiently large oval is cut by the scalpel, and a flap is then dissected outward in the vesico-vaginal wall on each side. Fig. 1765 represents the first incision, and the partial dissection of the flap. After the completion of the flaps, three or four silkworm-gut sutures are used to unite that of one side to that of the other, and then complete union is effected with the continuous catgut suture. The oval is thus completely covered. (Fig. 1766.)

This operation is comparatively bloodless, is easily done, and the results have been quite satisfactory. I can commend the method, not only from knowing what Dr. Winckel has accomplished with it, but also from having myself employed it.

[1] Münch. med. Wochenschrift, 1891.

It may be added that Dr. Winckel has adopted a similar method of operating for rectocele, not only on account of the small loss of blood,

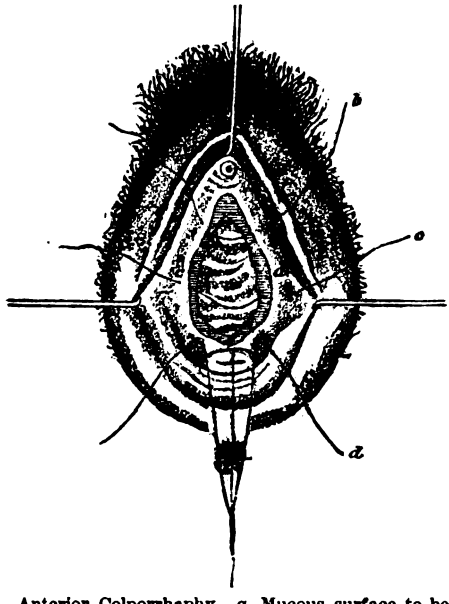
Fig. 1765.



Anterior Colporrhaphy. *a*, Mucous surface to be covered in by flaps, loosened on either side. (Winckel.)

but also because the buried part of the vaginal wall makes the recto-vaginal septum thicker, and because the stitches do not penetrate a part whose tissues are so rich in dilated veins.

Fig. 1766.

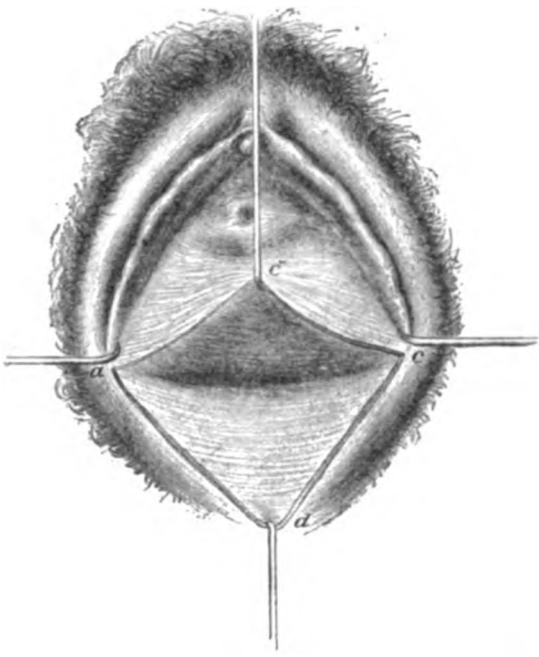


Anterior Colporrhaphy. *a*. Mucous surface to be covered in ; *b*, *c*, *d*, suture threads to approximate the parts *c* and *d*. (Winckel.)

Winckel's Posterior Colporrhaphia.

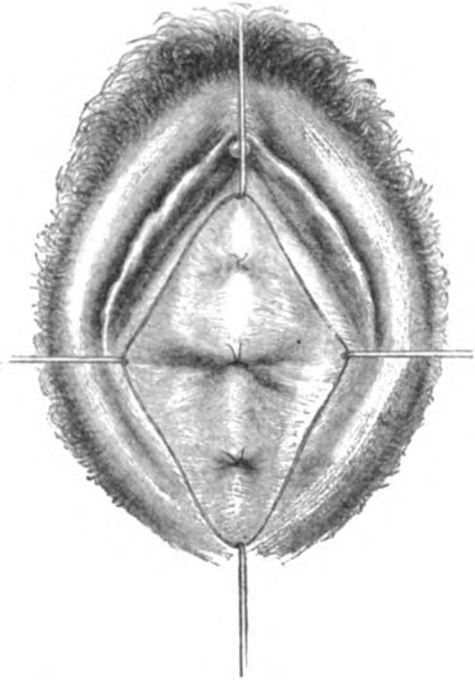
Prof. F. Winckel has devised an operation, designated by him as posterior colporrhaphy, for torn perineum, which as performed by himself has seemed one of the best of operations; he has kindly given me the illustrations herewith presented, while the description of the operation is derived from my witnessing him perform it. The patient occupies the usual position for such operations; the parts are thoroughly washed with soap and warm water, then an antiseptic washing follows, and during the progress of the operation constant antiseptic irrigation of the wound-

Fig. 1767.



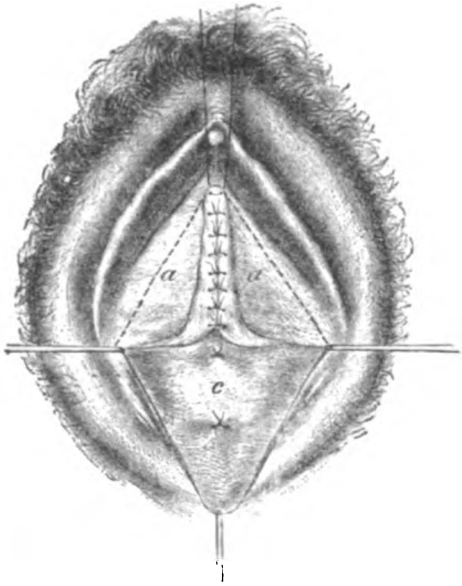
Posterior Colporrhaphy. Raising the flap. (Winckel.)

Fig. 1768.



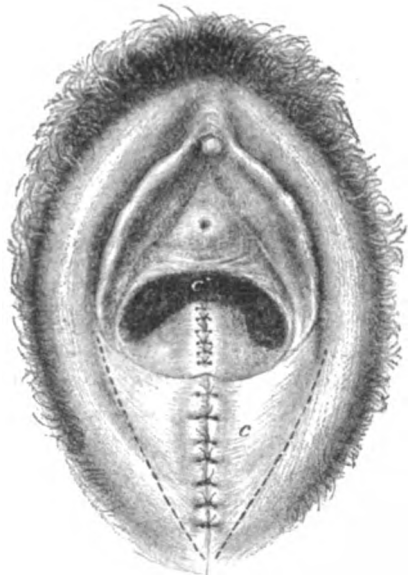
Posterior Colporrhaphy. The deep sutures in place. (Winckel.)

Fig. 1769.



Posterior Colporrhaphy. The sides of the upper triangle united. (Winckel.)

Fig. 1770.



Posterior Colporrhaphy. The operation completed. (Winckel.)

ed surface is practised. Two assistants, each having two tenacula, hold the parts to be incised tense, one tenaculum being inserted into the perineum close to its margin, one on each side near the lower part of the nympha, and the fourth upon the middle of the posterior vaginal wall, at about the height to which the splitting of the recto-vaginal wall is to reach. The operator then inserts the point of the scalpel near one of the lateral tenacula, and makes an incision half-circumscribing the vulval orifice, when the flap thus begun is dissected up until the surface represented in Fig. 1767 is presented, the upper tenaculum during the dissection having been changed so as to be inserted into the apex of the upper triangular portion. The next step is the insertion of three silkworm-gut sutures so as to include the middle third of the raw surface; these sutures, tied and cut off short, change the surface, hitherto quadrangular, into two triangles lying base to base, a condition represented in Fig. 1768. The next step is to unite the sides of the upper triangle by means of a continuous catgut suture, the result being represented in Fig. 1769. Finally, external sutures of silkworm gut bring the surface of the inferior triangle together, and close the perineum. (Fig. 1770.)

It has been complained of Tait's operation that it does not remedy a rectocele—it might with equal propriety be asserted that it does not cure hemorrhoids—but this objection cannot be justly made to Winckel's method.

Martin's Elytrorrhaphia and Perineauxesis.

In this, as in most other plastic operations upon the female genital organs, Dr. A. Martin, of Berlin, uses catgut exclusively; this has been made aseptic by eight days' soaking in corrosive sublimate and water, 1–1000, and is kept ready for use in a mixture of oil of juniper and alcohol, one of the former to two of the latter.[1]

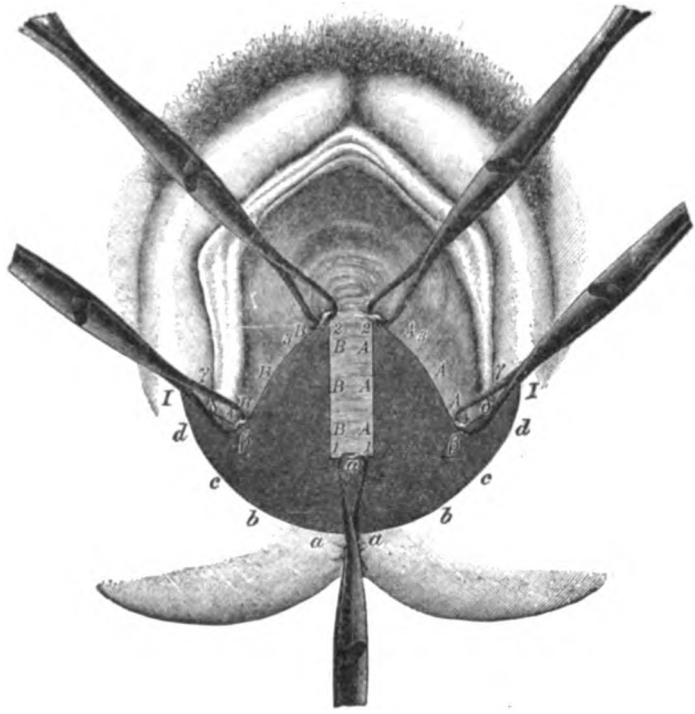
The operation consists of a double lateral posterior elytrorrhaphia, lessening the diameter of the vagina, and of a perineal operation, increasing the size of the perineum. The subjoined illustration shows the denuded surfaces; but it is to be remembered that the lateral operations upon the vagina are first done, and that the denuded surfaces are stitched on each side so as to be completely closed and covered, before the final operation. (Fig. 1771.)

It will be observed that, in the lateral elytrorrhaphies, the column which from embryological fact is richest in fibrous tissue, and therefore strongest, is left untouched in the denudation. Further, with the suturing on either side, the column is necessarily shortened.

In performing perineauxesis the first step is a transverse incision just at the lower end of the seams made by the elytrorrhaphies; from the ends of these, an incision is made on each side to the under margin of the nympha (3—1, Fig. 1771). Next an incision is made around the margin of the introitus, its ends uniting with those of the lateral incisions (*a b c d* to I). The tissue included in these incisions is denuded. The con-

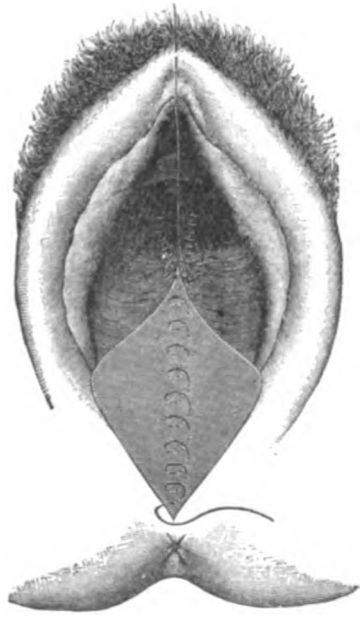
[1] Martin states (Frauenkrankheiten, dritte Auflage, 1893) that silk is used only in exceptional cases, though constantly for suture of the abdominal wound and ventrofixation, and that in vesico-vaginal fistulæ he employs silver wire.

Fig. 1771.



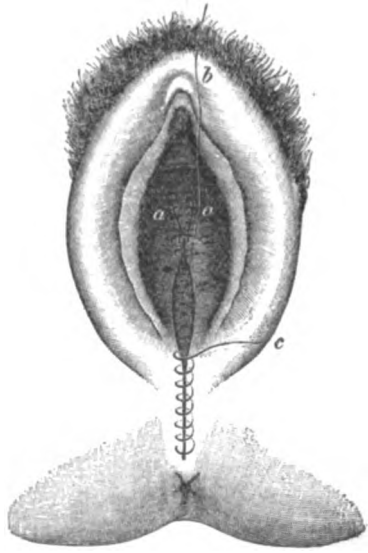
Freshened surface in Posterior Colporrhaphia. After A. Martin. 1—2, Lateral incisions near the posterior vaginal column. I. End of the freshened surface in the introitus. *A—A*, *B—B*, *a—a*, *b—b*, *c—c*, *d—d*, *β—α—β*, *δ—δ*, *γ—γ*, show the points that are to be united together.

Fig. 1772.



Continuous *Etagennaht* in Perineauxesis.

Fig. 1773.



Part of Martin's Prolapsus Operation, Perineauxesis. *a—a*, Lateral double elytrorrhaphia. *b*, Upper suture end. *c*, Lower suture end.

tinuous catgut suture, uniting in successive stages the tissues, *Etagennaht*, is used to first lessen the freshened surface and then finally to close the perineum. The annexed figures show the catgut suturing.

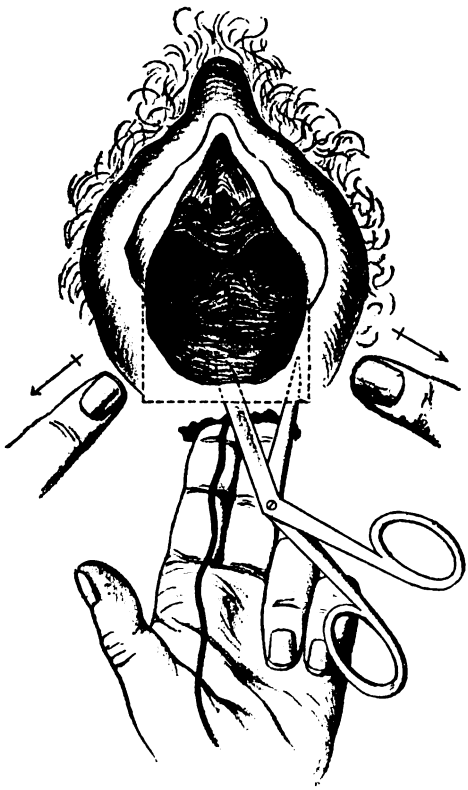
The after-treatment is, according to Martin, chiefly expectant. The patient's limbs are tied together, and she remains on her back for 17 or 19 days. A low bed-pan is used, if needed; retention of urine requires the catheter, carefully employed by a skilful hand; from the fourth day evacuation of the bowels is effected by castor oil, infusion of senna, or neutral salt. The vagina is not irrigated at all, but the vulva is washed after each urination. The patient may be at perfect liberty of movement at the end of two months, but sexual intercourse and hard labor ought to be avoided for two or three months after this.

Sänger's Method of Flap-Splitting Perineorrhaphy.

This plan is indicated for simple perineal laceration, in any degree, when uncomplicated by prolapsus or other deformity.

The patient having been prepared for operation, anæsthetized, and placed in the extreme lithotomy position, a well-anointed cotton tampon, with cord attached, is passed into the rectum; this protrudes the posterior vaginal wall and protects the field of operation from fæcal masses. The index and middle fingers of the left hand, placed within the bowel, now stretch the site to be repaired, while an assistant holds apart the labia majora.

Fig. 1774.

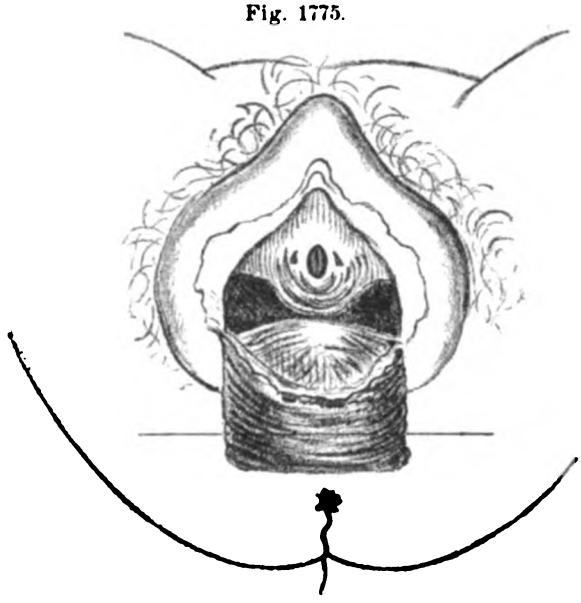


Sänger's Perineorrhaphy; mode of making incisions.

The recto-vaginal septum is divided transversely (Fig. 1774), the sharp points of the angular scissors (held horizontally) entering the median line at a point exactly between the posterior margin of the vagina and the anterior margin of the anal orifice. The blades, inserted to a depth of three-fifths of an inch, cut four-fifths of an inch to the right and similarly to the left (together one and a half inches), to a vertical line drawn on each side from the point of juncture of the labium majus and labium minus ("Labionymphal Grenze"). The vertical line on each side is then completed by further similar incisions of from one to one and a fifth inches in length, thus making the entire wound resemble a ⊔, which may be modified by cicatrices or other local conditions into a V

or a U shape, though the typical one is that first described (Fig. 1775). It is important to cut directly in the median line so as not to enter the vagina or rectum, especially as the entire incision requires but a half-minute's time for its completion. The slight venous hemorrhage, only occasionally present, is controlled by carefully sterilized silk of finest size. The edge of the flap just formed is grasped at its middle or apex by an artery forceps and held upwards, out of the operator's way, by an assistant, as shown in Fig. 1776.

Fig. 1775.



Appearance of Wound after Incision.

The wound surfaces are next to be adjusted, and the success of Sänger's modified plan depends greatly on the method of introduction of sutures for this purpose. Contrary to Lawson Tait, Sänger first unites the vaginal flap by four, five, or six silk sutures, passed from right to left, and tied externally, or on the mucous membrane (Fig. 1777). In this way the operator avoids forming a superfluous "spur," and also entirely prevents necrosis of the flaps, two strong objections to previous methods of flap-splitting perineorrhaphy. (Fig. 1778.)

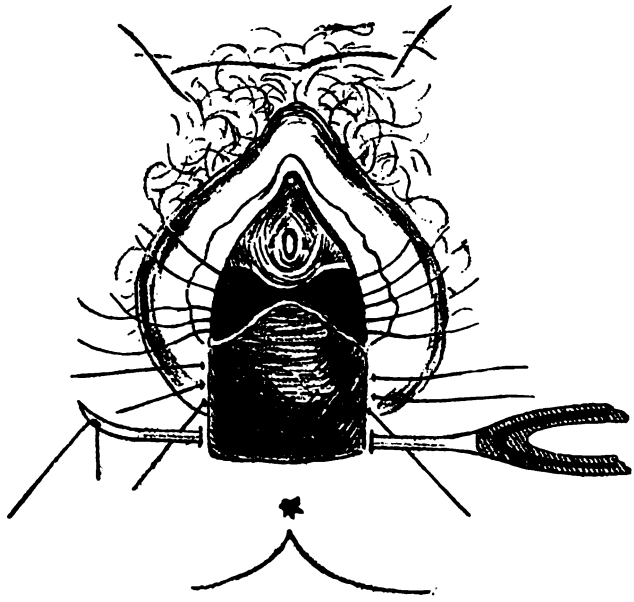
Fig. 1776.

Vaginal Flap Raised by Forceps Ready for Suturing.

To repair the perineum, a Peaslee needle of well-tempered steel, or an ordinary half-circular needle and needle-holder, may be employed. This is entered through the skin, just beyond (1 mm.) the margin of the wound, from the surgeon's right side; is passed beneath the entire cut surface, and emerges at a similar point, exactly opposite, on the left side of the flap. The fingers of the left hand, placed within the rectum, aid this manœuvre by pressing forward the recto-vaginal septum. Silver wire, unpolished and of medium size, is now inserted into the eye of the needle, and the latter, so armed, is withdrawn. About five of these sutures will suffice, and their order of insertion is immaterial, except that one must be so placed as to lie exactly beneath the median line—the deepest point of the wound—so as to avoid any "dead room." Then, by simply twisting the wires by hand, the wound is closed.

Sänger finally passes the ends of the sutures through a perforated shot, compressing this and cutting the ends short just beyond, preventing in this way any irritation of the surface, and allowing easy access for re-

Fig. 1777.

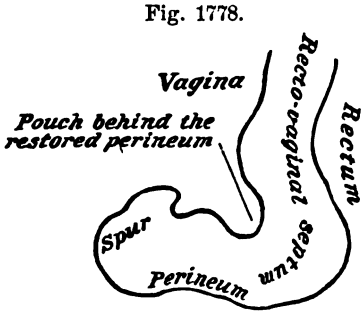


Mode of Introducing Sutures.

moval of the sutures. Superficial stitches of silk are inserted to close any gaping points in the line of the wound. The latter is then thickly strewn with iodoform and covered with a pad of iodoform gauze, one end of which is inserted into the vagina. A mass of sublimate wood-wool completes the dressing, and, the thighs being approximated, the patient is transferred to her bed.

The post-operative treatment comprises the use of the glass catheter twice daily for the first five days, always followed by blowing freshly powdered iodoform over the wound. This forms a sort of soft iodoform scab, absorbing all fluids and maintaining the line of sutures in a perfectly dry condition. Sänger lays stress on regularity of defecation, giving a laxative on the fourth or fifth day, and each second or third day thereafter—the anal region being carefully irrigated after every action. Should, however, the bowels move before the fourth day after the operation, no harm need be feared, owing to the early union of the wound surfaces.

Fig. 1778.



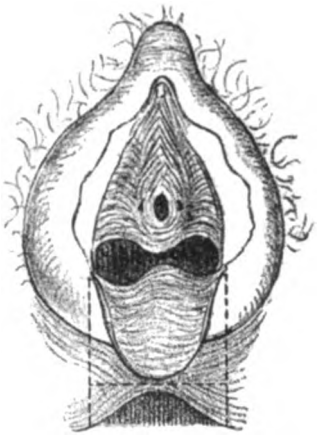
Schematic Figure, after Sonntag, Showing Faulty Repair of Lacerated Perineum by the Formation of a Spur with Pouch.

The superficial sutures are removed on the seventh day and the deep ones on the fourteenth day after repair, when the patient may be allowed to leave her bed.

SÄNGER'S OPERATION APPLIED TO DEEP PERINEAL LACERATION.

With the patient lying in the exaggerated lithotomy posture, and prepared for operation as already mentioned, a hand is placed upon each gluteal prominence to retract the parts forcibly, and to show the entire cicatrix back to the torn ends of the anal sphincter. Next the surgeon should note carefully whether the recto-vaginal septum consists of rigid cicatricial tissue, or whether, as Sänger particularly notes, a pseudo perineum is left—a high, rigid, cicatricial wall, generally deeply placed—as the lateral cutaneous boundary. He incidentally explains that this variety is one in which the injury has involved mostly the rectum and contiguous perineum, but the vaginal surfaces scarcely at all. In the contraction which follows secondary union by granulation, this vaginal surface is correspondingly retracted, and we must therefore deal with vaginal tissue and not with a perineum. This bar is best divided by the Paquelin thermo-cautery. The transverse incision, because of the thinness of the remaining tissue, is best made by a small scalpel. Then the anterior lateral incision is extended backward to the torn ends of the anal sphincter, so that the entire lines of incision resembles an H in which the posterior lateral bars are shorter than those anterior to the transverse incision.

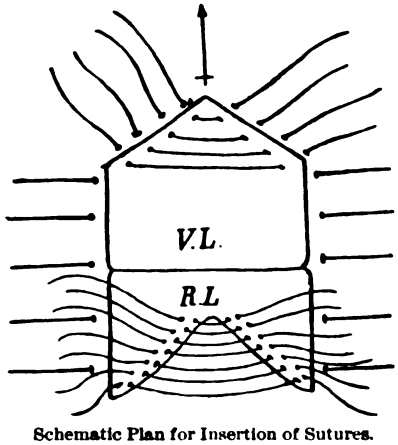
Fig. 1779.



Sänger's Posterior Colporrhaphy, Showing Lines of Incision.

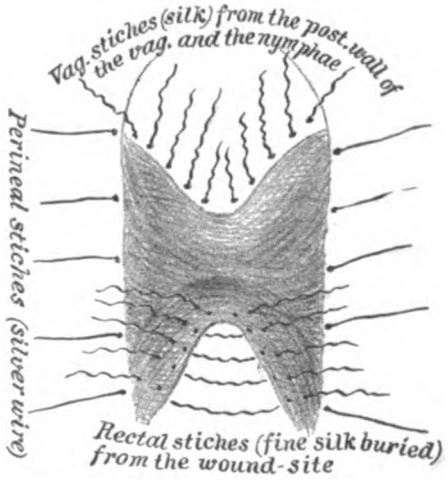
The vaginal flap is united as first described; the rectal defect, if not too extensive, requires no especial attention, as its edges fall into accurate contact on approximation of the perineal sutures. When the lacer-

Fig. 1780.



Schematic Plan for Insertion of Sutures.

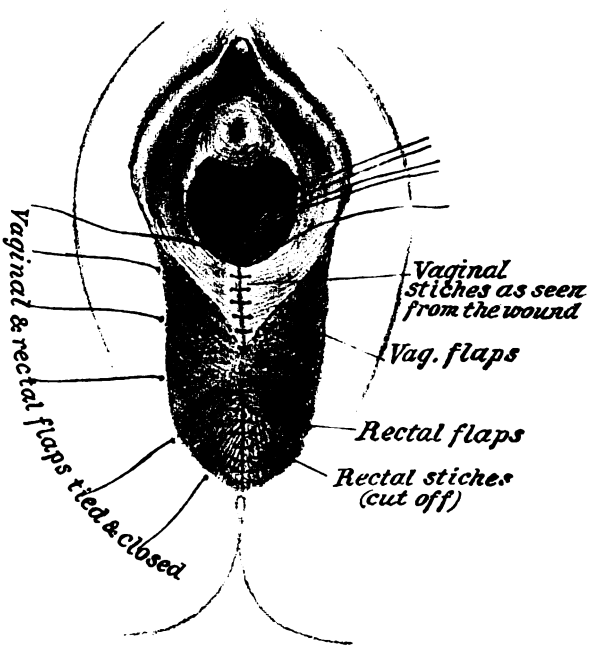
Fig. 1781.


Vag. stiches (silk) from the post. wall of the vag. and the nymphae
Perineal stiches (silver wire)
Rectal stiches (fine silk buried) from the wound-site

Sutures in Position.

ation extends high up the rectum, the H incision is made and stitches are placed in the vaginal flap as already described. Then the V-shaped hiatus or defect remaining in the rectal flap is closed by the Lauenstein suture (practically that of Lembert), the stitches being inserted only from the surface of the wound. The operator inserts the needle into the rectal flap from his right side, causing it to emerge just short of the margin of the wound, and then making it cross the hiatus, enter, and similarly emerge on the opposite side. In this manner sutures are inserted in close order from the apex to the base of the rectal flaps, and, when tied, accurately unite the line of the wound. They present neither silk suture nor wound surface to be acted on by the rectal contents—only mucous membrane can be seen on examination by the speculum. (Figs. 1779, 1780, 1781, 1782.)

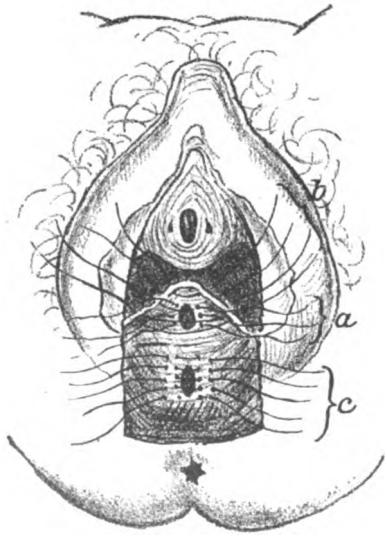
Fig. 1782.


Vaginal & rectal flaps tied & closed
Vaginal stitches as seen from the wound
Vag. flaps
Rectal flaps
Rectal stitches (cut off)

Sutures Tied.

The perineal structures are next closed by silver wire, with superficial silk sutures where necessary. The after-treatment differs in no wise from that already described.

Fig. 1783.



Sänger's Method of Closing Recto-Vaginal Fistula. Mode of introducing sutures.

Flap-Splitting Repair of Recto-Vaginal Fistula.

Division of the perineo-vaginal bridge found in this deformity may or may not be required in perineorrhaphy by flap-building. If left undivided, then the procedure is exactly that just described for simple laceration.

The vaginal flap is, as before mentioned, shaped by one transverse and two lateral incisions, and the fistulous tract in this portion is closed by buried Lauenstein (Lembert) sutures of fine silk, as shown in Fig. 1783. Similar buried sutures close the remainder of the fistula in the rectal flap. The vagi-

nal flap is closed by the usual external stitches of silk, and the perineum by silver wire, with, possibly, silk for any gaping points. This plan answers when the fistula is small and deeply placed, as, also, in such fistulæ as have an orifice at the vaginal introitus, provided there exists a strong perineum with an intact sphincter.

On the other hand, the fistula may be large and more deeply situated, with a thin perineal bridge and a relaxed gaping anus, the sphincter of which has lost its function. It is here that simple division of the remaining bridge of perineal tissue will change the deformity into that of complete perineal laceration with involvement of the bowel. Then the typical operation is followed: The recto-vaginal septum is transversely divided and the two anterior lateral extensions of the incision made to form the vaginal flap, this being at once closed by sutures of silk. Then, if the rectal laceration is not too extensive, it will be simply necessary to unite the perineum by deeply placed silver-wire sutures, with, perhaps, a few external rectal stitches of silk.

When the rectum is more deeply torn, then, before twisting the perineal wire sutures, it will be necessary to unite the freshened crura of the rectal wound, just as in the operation for complete laceration, by buried Lauenstein sutures of silk. The further treatment differs in no wise from that of the latter procedure.

PERINEOTOMY.

A partial perineotomy is done in Tait's and in several other operations for restoration of the perineum, but a complete perineotomy is splitting the entire recto-vaginal wall so that Douglas's cul-de-sac is opened. This operation was first proposed by Dr. Otto Zuckerkandl, of Vienna, in 1889, and has been used in a few cases of extirpation of the uterus. His method was this:[1] The perineum was incised in the form of a trapezium, the base turned toward the sacrum; the transverse branch was seven centimetres in length, and three centimetres in front of the anus, while the oblique branches extended to the ischial tuberosities; then the rectal was dissected from the vaginal flap until the peritoneal cavity was reached and opened. The accompanying illustration shows the perineal incisions. (Fig. 1784.)

Fig. 1784.

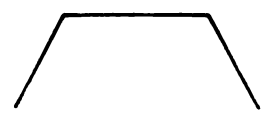


Diagram of Zuckerkandl's Operation of Perineotomy.

Sänger in 1890 employed lateral perineotomy for the removal of a dermoid cyst of the pelvic connective tissue. He made an incision which began at the posterior third of the labium majus, extended to two centimetres behind the anus, and in the middle of the space between this opening and the ischial tuberosity.

By a typographical error this method, attributed to Hegar and Sänger, is called vertical perineotomy by Bonnet and Petit.[2] (Fig. 1785.)

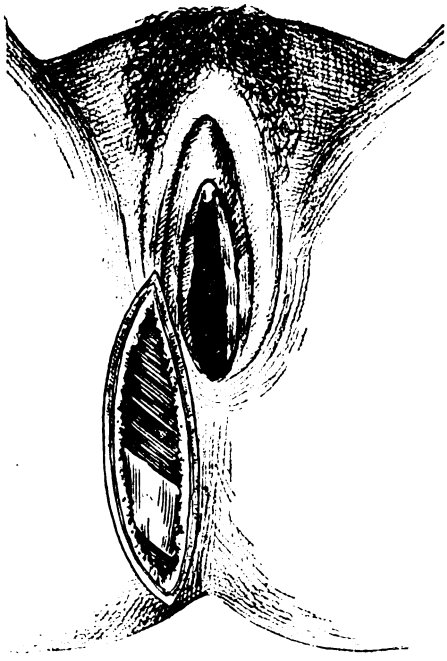
Willems, whose monograph may well be consulted by any one who wishes not only the history of the operation, but the method of perform-

[1] See monograph, "De la Périnéotomie et de ses Applications," by Dr. Ch. Williams, assistant at the University of Gand, 1892.

[2] Pratique de Gynécologie. Paris, 1894.

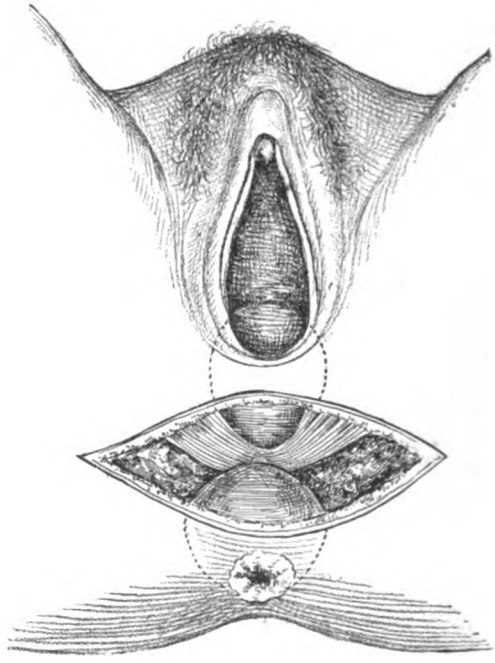
ing it in the male as well as in the female, and its applications, advises, in operating upon the female, that if the perineum is intact, the transverse incision should be two centimetres in front of the anus, but that if there has been partial rupture this incision should be directly in the middle of the tissue between the anal and vulval openings, while the lateral incisions should follow the internal borders of the ischial tuberosities, and should pass beyond. The anterior flap is held by an assistant while the operator draws the posterior one below, and divides the tissues with scissors until separation of the rectal sphincter is accomplished, when the finger is used in the median line to separate between the rectum and the vagina; the blunt dissection must now for the moment be discontinued, and the scissors used, by means of a few cuts

Fig. 1785.



Hegar and Sänger's Lateral Perineotomy. (Bonnet et Petit.)

Fig. 1786.



Willems's Transverse Perineotomy. (Bonnet et Petit.)

with which the fat of the ischio-rectal sinus is traversed and the inferior border of the levator divided; the separation with the finger is then resumed until again some fibres of the muscle require scissors for division, when the fingers readily complete the work, and the peritoneal cul-de-sac is reached, recognized by its bluish color, caught with tenaculum forceps, and cut with scissors, the cut being continued on each side as far as necessary. A pyramidal opening is thus secured, quite large enough for the introduction of the hand. In this operation there is more danger of wounding the rectum than the vagina, if one does not accurately pursue the natural plane of cleavage between the two organs, or when the scissors are used to divide strong adhesions; therefore, to guard against this accident, Willems advises not to draw too strongly upon the rectal flap nor to press too greatly with the finger in the separa-

tion, to retain a finger in the rectum during this process, as a guard, and finally, when the scissors are used, to turn their points toward the vagina. (Fig. 1786.)

Willems adds to the application of this operation for extirpation of the uterus, its use in some cases of pelvic suppuration, pelvic hematocele, and tumor.

Zuckerkandl, in regard to its employment in extirpation of the uterus, claims that it offers all the advantages of the operation of Kraske; the space is quite as great; as in sacral resection, the uterus and its appendages can be examined, the broad ligaments can be divided while seen, the uterine artery tied, and wounding the ureters avoided. Among the accidents that have followed the so-called Kraske's operation, the following are mentioned[1] by Bonnet and Petit: Hemorrhages from the pre-sacral and uterine arteries, tearing, perforation of the rectum, of the small intestine, of the bladder, or of the ureter, urinary or fæcal fistulæ, and sacral necrosis.

Sänger's Substitute for Emmet's Operation for Lacerated Cervix, and Amputation of the Uterine Lips.

Sänger in place of, in the usual manner, paring and stitching the surfaces of a torn cervix together, performs the following operation in some cases of bilateral laceration: An incision is made in the sound tissues above the apex, and extended on each side of the tear until near the lower portion of the lips—here the tissue is kept intact. Next the flap thus formed is drawn down so that the freshened surfaces behind it can be brought into immediate contact; these surfaces are then stitched together, the flap being thus pushed down to the external os, and indeed in part projecting beyond the surrounding surface.

The objections made to this operation are that diseased tissue may be, and often is, thus retained; and that the projection formed by the flap thus thrust down by no means restores the parts to a natural condition.

In some cases of bilateral laceration, instead of performing trachelorrhaphy, experience has taught me that it is very much better, as Martin does, to amputate a portion of each lip. Given considerable enlargement of the womb, the so-called subinvolution of the uterus—often really the consequence and the condition of inflammation—an obstinate uterine catarrh, possibly menorrhagia, possibly, too, a history of repeated miscarriages, it is, I believe, better to remove a portion of each lip, stitching the surfaces of each thus left raw, by catgut; this amputation is preceded by curetting the uterus, and by the injection of Churchill's tincture of iodine.

It should be remembered that in this, as well as in other of Dr. Martin's operations upon the sexual organs, previously described, the most careful disinfection is carried out before and during the operation, the latter by constant irrigation with a three-per-cent. solution of carbolic acid. This scrupulous care, he believes, explains the almost invariable exemption of his patients from septic infection.

[1] Op. cit.

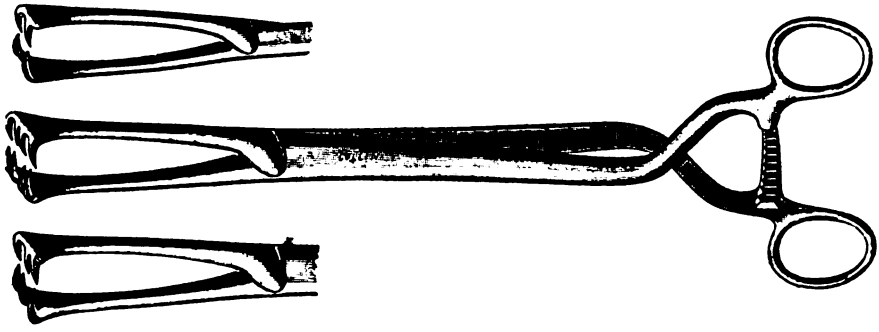
Vaginal Hysterectomy.

Vaginal extirpation of the uterus is most frequently done for cancer,[1] whether of the neck or of the body, though in the former position, if the disease be limited to the vaginal cervix, excellent authorities prefer removal of the diseased tissue with the electric cautery (Byrne, of Brooklyn), or high amputation (Baker, of Boston). And indeed to extirpation of the uterus on account of cancer, there is by no means unanimous assent, Tait, for example, and more recently Madden, doubting its expediency. Nevertheless the opponents to the operation form but a small minority.

For some days preceding the operation an antiseptic vaginal injection, followed by the introduction of antiseptic gauze, is used every twenty-four hours. If the vagina is narrow, preliminary dilatation is employed; for this purpose Doyen uses the balloon of Gariel for forty-eight hours.

Strong forceps, with two, three, or four teeth, represented in the subjoined figure, will be needed to seize the cervix, and draw it ante-

Fig. 1787.



Traction Forceps, Bident, Trident, and Quadrident. (Bonnet et Petit.)

riorly, posteriorly, laterally, or downward as may be required in the different stages of the operation. (Fig. 1787.)

Illustrations of different vaginal separators are presented in Figs. 1788, 1789, 1790, 1791; these instruments are those of Doyen, Péan, and Segond. In addition to ordinary scissors, there should be a pair of long scissors, curved on the flat, and also a scalpel. The question of hæmostasis, whether by ligation or by clamping the broad ligaments, will determine as to having at hand material for ligatures, or clamp forceps. Most operators prefer ligatures to clamps, and the material commonly used is catgut, though I have seen Winckel use silkworm gut satisfactorily. Clamp forceps, originally suggested by Sir Spencer Wells, were probably first actually employed by Richelot; various different forms have been invented, and until recently one forceps was used on each side; but now, according to the statement of

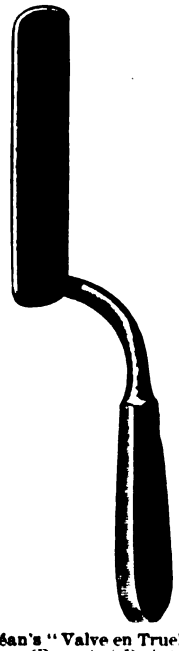
[1] In my former contribution to this work, I expressed doubt as to the truth of the statement made by several authorities in regard to the negress being relatively exempt from uterine cancer. Dr. Michel, of Charleston, S. C., in the Medical News, October, 1892, proves by his own statistics that the liability to the disease varies but little in the African and in the Caucasian

Bonnet and Petit, it is better not to include the entire broad ligament with a single instrument, the method of employing clamps generally

Fig. 1788.

Doyen's Retractor. (Bonnet et Petit)

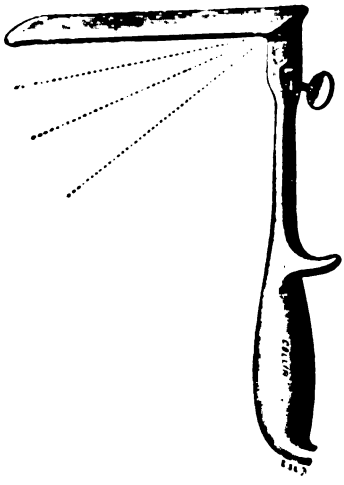
Fig. 1789.



Péan's "Valve en Truelle." (Bonnet et Petit.)

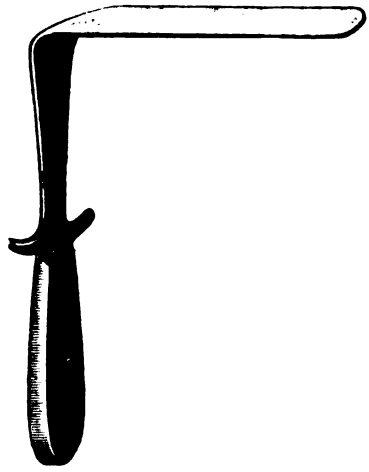
accepted, but to use two or three for each side; the first clamps having been applied to the inferior halves of the broad ligament, the tissues that have been thus secured against hemorrhage are divided; the uterus is then drawn down until the superior halves of the ligaments

Fig. 1790.



Segond's Retractor with Movable Angle. (Bonnet et Petit.)

Fig. 1791.



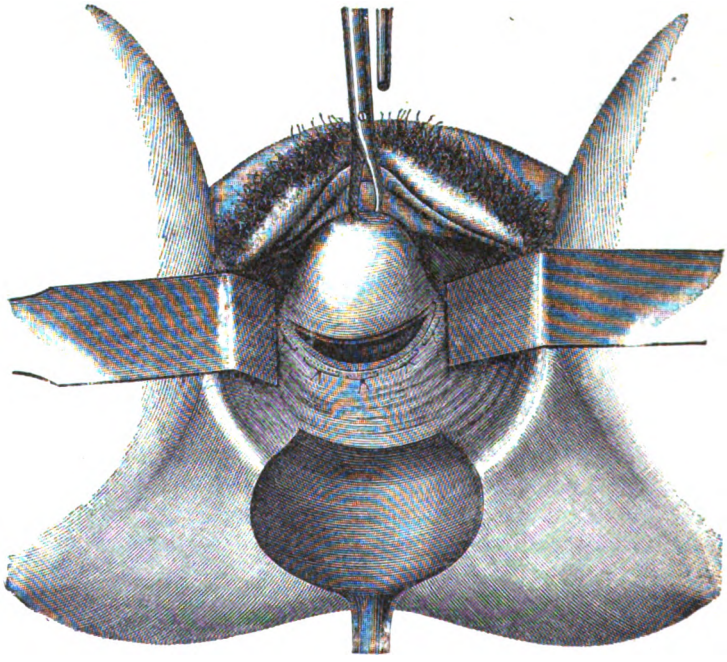
Straight and Long Retractor. (Bonnet et Petit.)

are accessible, when the second set of clamps is applied; this not being sufficient, a third is used, and the uterus is freed by dividing the remaining portions of the ligaments. Small hæmostatic forceps are at hand.

In case ligation is employed, properly prepared antiseptic catgut is ready, and strongly curved needles and needle forceps, or, as some operators prefer, the Deschamps needle; Olshausen uses the latter with different curves, while Martin employs the former.

The patient is in the dorso-sacral position, the parts are thoroughly disinfected, and strong toothed forceps (Fig. 1787) are employed to seize the cervix. The uterus is first drawn forward by the forceps, so that

Fig. 1792.



Vaginal Extirpation of Uterus. Douglas's pouch opened. (Martin.)

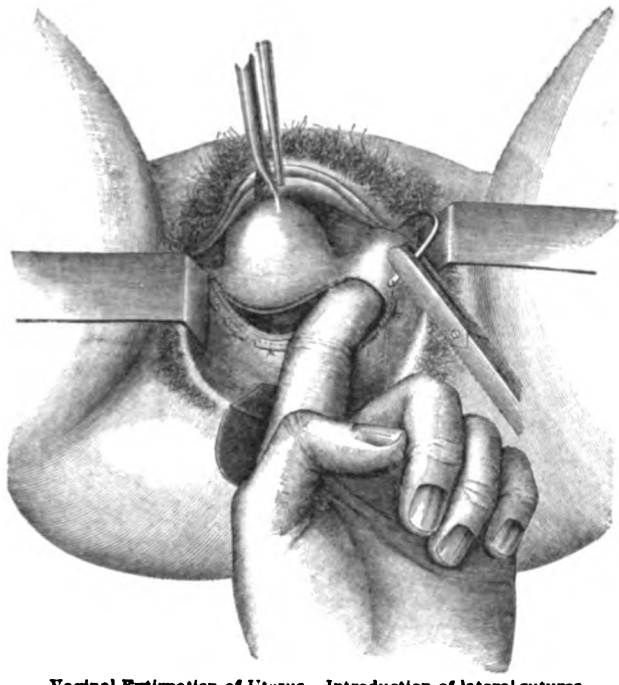
the posterior cul-de-sac is exposed, and the operator opens through it into the peritoneum, cutting closely to the uterus. (Fig. 1792.)

Martin then stitches the vaginal and peritoneal surfaces of the wound together. The next step is the introduction of lateral sutures, one on each side; each stitch is carried so deeply as to include the base of the broad ligaments, and if not the uterine artery, at least its lower branches. (Fig. 1793.)

This accomplished, the operator next opens the anterior cul-de-sac, the cervix being drawn backward; a semicircular incision is first made, and then the separation of the connective tissue between the uterus and the bladder is accomplished with the finger, though the knife or scissors may occasionally be required to divide firm tissue. Some object, on the ground of risk of infection, to immediately opening the peritoneal cavity, but Martin does it at once, and, as in the posterior opening,

stitches the peritoneum and vaginal wall, these stitches, usually four, immediately arresting the bleeding. The uterus is now retroverted, the broad ligaments on each side are in succession ligated, beginning at the upper portion, now the lowest, and three ligatures being employed; after one side is ligated —it is usual to begin with the left—the tissues are cut close to the uterus, and then the ligation of the still attached side is easily effected.

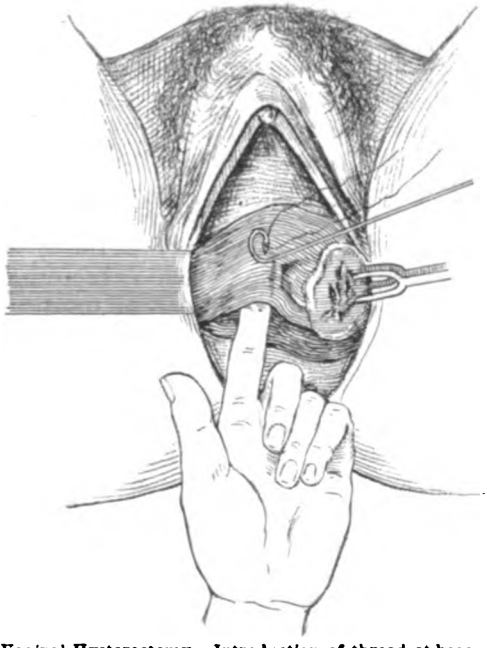
Fig. 1793.



Vaginal Extirpation of Uterus. Introduction of lateral sutures. (Martin.)

In case the operator prefers ligation *in situ*, the cervix is drawn to the opposite side to that which he wishes to tie, a Deschamps needle is passed from before backward, the catgut is withdrawn, the needle removed, and the former tied (Fig. 1794). By a similar manœuvre, a ligature is placed upon the other side; after the ligation, the tissues are divided close to the neck. The uterus, now more movable, is drawn down, and again ligatures are introduced, to include more of the broad ligament, on each side; again the tissues, hemorrhage being thus prevented, are divided, and the uterus is drawn still lower, so that often a third ligature on each side includes the remaining portion of the broad ligament.

Fig. 1794.



Vaginal Hysterectomy. Introduction of thread at base of right broad ligament. (Bonnet et Petit.)

The Use of Clamp-Forceps. —If this means of preventing hemorrhage is preferred, some have applied the instrument with the uterus drawn down, after retroverting it; in either case, both anterior and poste-

rior culs-de-sac must have previously been freely opened. The clamp must be applied about one centimetre from the uterus, and after it has been made tight, the tissues are divided close to the womb; then the clamp is applied upon the other side, and the section is completed. The fact that it is preferable to effect the hæmostasis in two or three stages has already been mentioned, and for this smaller instruments, four or six in all, will be employed.

The forceps are removed at the end of forty-eight hours. Some operators simply fill the opening in the vaginal vault with iodoform gauze, and all use this in the vagina as a drain; if clamps are employed, the same material is wrapped around those portions of the instruments which are in contact with the vulva. It is generally regarded as best to at least partially close with sutures the vaginal vault.

The removal of the uterine appendages, in case they are diseased, or in case the subject is comparatively young, is to be added.

Other methods of removing the uterus by the vagina are Müller's (total median section), Doyen's (median hemisection), and Péan's, or Segond's (*morcellement valvulaire*).

According to Bonnet and Petit, *morcellement* constitutes an important addition to our modes of treatment, which should be justly attributed to Péan. It permits ready but otherwise impossible removal of a uterus, and its advantages are well-defined, as regards operative facility and safety, in the first of the rules for its execution: Never remove a fragment without seeing it, and without having seized the tissues above it.

Para-Sacral and Sacrococcygeal Extirpation of the Uterus.

Kocher removed the coccyx in order to reach the posterior face of the rectum high up, and in 1885 Kraske, for the same purpose, not only removed the coccyx, but also the lower portion of the sacrum. Prof. E. Zuckerkandl[1] made known the exposure and accessibility of pelvic organs accomplished by parasacral section, that is, by an incision along the inferior lateral border of the sacrum, extending along the side of the coccyx and to its point, and claimed that this operation could replace that of Kraske; the same view was upheld by Professor A. Wölfer, of Gratz, who thus successfully operated.[2] Willems states that the operation is much more difficult and laborious, and longer than sacrotomy. We may omit, therefore, further reference to the parasacral method, though it has met the approval of Kufferath.

Three years after Kraske's communication—his object was to be able to remove growths occupying the superior part of the rectum—Hochenegg and Herzfeld proposed the application of his method to removal of the uterus, and the first operations of this kind were by the former and by Gersuny, the operation being afterward repeated by Ullman, Hegar, Salzer, Czerny, and others. But operators have differed as to the amount of bony structure to be removed. Thus Czerny[3] removed only the coccyx; Hochenegg, Gersuny, and Müller, in addition to the coccyx, a small portion of the latero-inferior part of the sacrum; while

[1] Wien. klin. Wochenschrift, 1889, Nos. 14 und 18. [2] Ibid., No. 14.
[3] Bonnet et Petit, op. cit.

others, Bardenhauer and Roux, of Lausanne, removed the coccyx and all of the sacrum below the third sacral foramina.

Hegar modified the operation by including the bony tissues, which others removed, in a flap, which was pushed to one side until the uterus had been extirpated, and was then restored to its proper place.

The usual method, after temporary or final resection of the coccyx and the inferior extremity of the sacrum,[1] is to pass along the side of the rectum until the recto-vaginal cul-de-sac is reached, to open it, and then to draw the uterus posteriorly, dividing the broad ligaments from above, and applying ligatures; the uterus is then retroverted so as to come into the sacral wound, and finally the cervix is forced anteriorly by cutting from above downward in the vesico-uterine space.

Willems states that the great advantage of this operation is the extent of the operatory field furnished—in the cadaver, the uterus being of normal volume, all the internal genital organs are plainly disclosed; the fundus and the posterior face of the uterus, the broad ligaments, the tubes and the ovaries, are visible in all their details, and even the anterior wall of the abdomen above the bladder.

It should be remembered that this is a much more grave operation than vaginal hysterectomy, for it is long, Czerny stating that upon the average it lasts two hours, and is attended with considerable bleeding. Pozzi thus speaks of the method: It affords "a valuable resource for cases in which the uterus is too large, or the vagina too narrow to allow access by the natural passage. But this newly-devised method of facilitating an operation will not alter the limits which I have laid down as those within which one must keep in performing hysterectomy. Whenever the cancer has spread beyond the limits of the uterus, one should refrain from attempting total extirpation."

Martin, in the recently issued last edition of his work upon diseases of women, briefly refers to this method, but adds that he has never employed it.

[1] Willems, op. cit.

CONSTRUCTION AND ORGANIZATION OF HOSPITALS.

BY

EDWARD COWLES, M.D.,

SUPERINTENDENT OF THE McLEAN HOSPITAL, WAVERLEY, MASS.

THE remarkable advancement of scientific medicine during the last decade has been notably manifested in the special development of hospital construction. The admirable work on Hospital Construction and Management," by Mouat and Snell, 1883, was superior to any before published on that subject. More recently, 1891, Burdett's greater work on the Hospitals and Asylums of the World with its four large volumes and portfolio of plates, furnished not only a mine of information upon the construction, organization, and management of such institutions, but presented the results of exhaustive studies of their relations to the public. Still more recently a noteworthy volume has appeared on Hospitals, Dispensaries and Nursing, being the papers and discussions in the International Congress of Charities, Correction and Philanthropy at the World's Columbian Exposition at Chicago, edited by Drs. Billings and Hurd. The very facts of such a convention of interests that have hitherto seemed so scattered, and the bringing together in one volume of a systematically ordered series of discussions of the many phases and details of hospital work and life, are eventful in the history of hospitals. That far-reaching and beneficent results are to follow from organization of these interests cannot be doubted.

The principles established by the experiences of the civilized world in the care of the sick and wounded of the great wars in the third quarter of this century have been newly applied in the last ten years, in constructive forms adapted to special purposes. These are to be seen in the devices called for by modern scientific surgery, in the rapidly spreading tendency to the building of small hospitals, even in towns and villages, and in the movement, well advanced in England but only fairly beginning in America, for the provision of hospitals for infectious diseases, which may lead to the creation of health stations for the protection of every community by the prevention of disease.

It is easy to trace the activity in these three directions to a common cause—the development of the new science of bacteriology. This science has shown the need of complexity of manipulation in aseptic surgery, which reduces the art to greater exactness that may be acquired by practice. Modern progress has tended to the development of

specialties, particularly in those involving surgical manipulations. Thus there are required special constructional conditions to insure the success now expected from surgical interference: and many things that can be done for the preservation of life and for restoration to health, can only be done in hospitals. Special operating rooms are now the demand of every great hospital; and every community desires the facilities for hospital care near at hand. The successful establishment of these many small hospitals has now become possible through the services of intelligent women trained to the nursing of the sick and to executive work.

The newly awakened interest in preventive medicine, as applied to protection against infectious diseases, is in like manner due to the better knowledge of the causes of disease, that bacteriology has taught. Very distinct forms of hospital construction have grown out of the precision with which the special requirements of this work have been demonstrated.

This affords another example of the progress toward a general system of national sanitation, of which the village hospitals will be the important result. There will then be a more complete legislative control of the interests in which the guardianship of life is concerned. "In the end," writes Havelock Ellis, "every medical man in the country would be attached to a hospital, and every person would be living within the district of a great institution of health."

Hospital Improvements to Promote Aseptic Surgery.

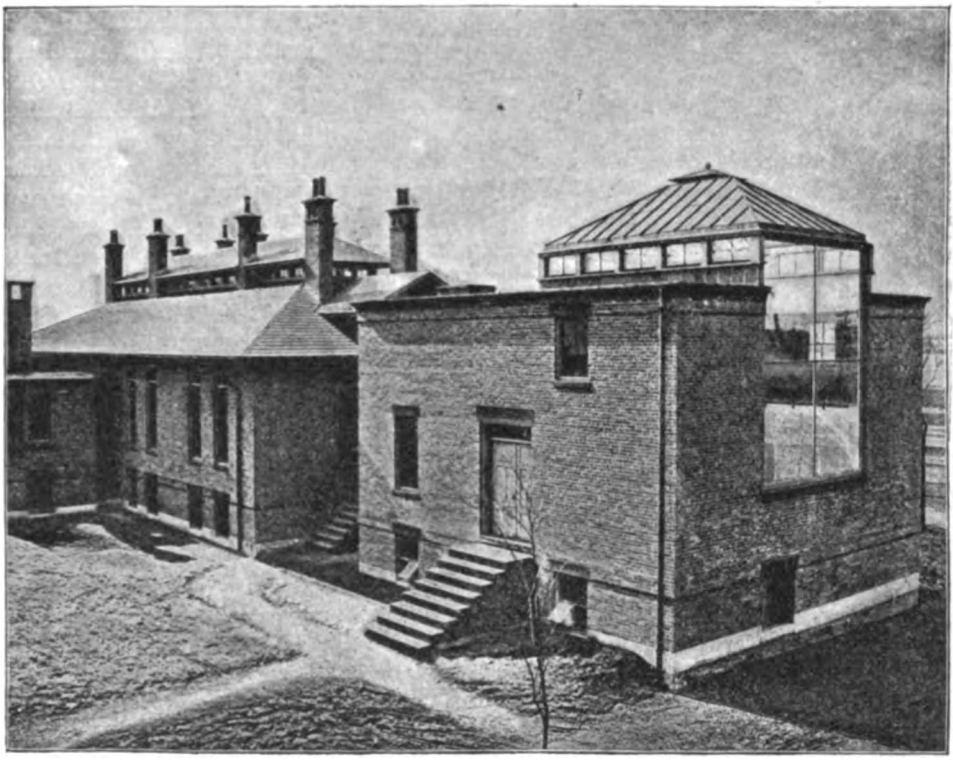
The purpose of this article is to note recent progress in hospital construction, especially in the three ways just mentioned. The first of these relates to the invention of special devices for promoting aseptic surgery; and there are now in existence some unique examples of such surgical buildings and operating-rooms. The first notable structure of this kind was erected at the Massachusetts General Hospital in 1888, as a memorial building, the Bradlee Memorial Ward for abdominal and cerebral surgery. It is a one-story pavilion, and its plan and exterior are shown in Figs. 1795 and 1796.

The building is connected with the other parts of the hospital by a basement covered way for food-service, but the approach to the ward on the first floor level is by an uncovered terrace. The ward itself has the general arrangement of rooms designed for isolation, the corridor between them being 8 feet wide and 24 feet high, with a monitor roof with many windows that may be freely opened. This gives the corridor, in relation to the rooms, the effect of their opening upon the outer air. The lavatory, scullery, etc., are outside of the building, with an intervening lobby protected at the side only by a screen. The passage is guarded by double doors swinging both ways. The heating is by steam and indirect radiation, the inlets being under the windows. These have transom lights over them. The ventilation is by an independent duct in the chimney for each room. The walls and ceilings are painted, the floors are of hard pine, and the finishing in wood and plaster has all corners rounded.

The special feature of the building is the operating theatre. At the

northerly end a door from the main corridor opens into a connecting lobby. A door to the right opens upon a flight of steps intended for

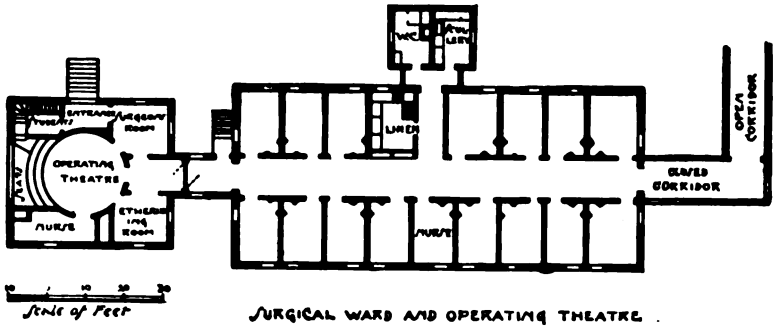
Fig. 1795.



Bradlee Ward and Theatre.

the entrance and exit of the hospital attendants. Beyond the swinging doors, one in front opens directly to the amphitheatre floor, one on the right to the surgeons' consultation-room. Doors from either room

Fig. 1796.



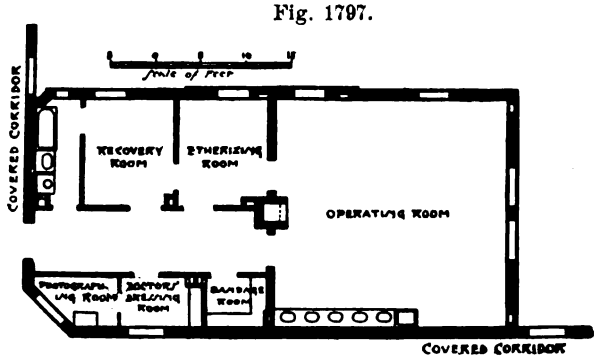
Surgical Ward and Operating Theatre, Bradlee Memorial Ward.

connect with the theatre. The walls are of pressed brick; the floors, like those of the corridor and theatre, are of asphalt.

The floor of the amphitheatre is circular in outline, with a diameter of 18 feet. Directly over this is a monitor roof of hammered glass, with an area of 280 square feet. Contiguous with this glass roof, at the northerly end of the theatre, is a window made of four sheets of plate glass, the combined area of which is 192 square feet. Beginning at either side of this window is a wainscoting of polished white Italian marble, which encircles the whole operating space. Above this wainscoting, and projecting over it, is the first circle or tier of the balcony, guarded in front by a heavy iron and brass railing. The balcony affords standing room for about one hundred spectators. Opening out of the amphitheatre, on the westerly side, is a general supply-room. The corresponding space on the easterly side is a passageway from an outside entrance leading to the balcony, or, through an arched opening in the marble wall, to additional standing-room for twenty-five spectators. This standing-room is obtained by three semicircular tiers of marble flagging, extending from the amphitheatre floor to the sill of the large northern window. The entire basement is concreted. It has no stairway connection with the floor above. The ward and theatre are lighted by electricity.

This hospital has recently added to its principal operating theatre some ingeniously devised sterilizing apparatus in special rooms for the purpose, and other rooms for the work of a clinical laboratory, a provision which is now becoming a necessity for every great hospital.

Fig. 1797.



Gynæcological Operating-room, Johns Hopkins Hospital.

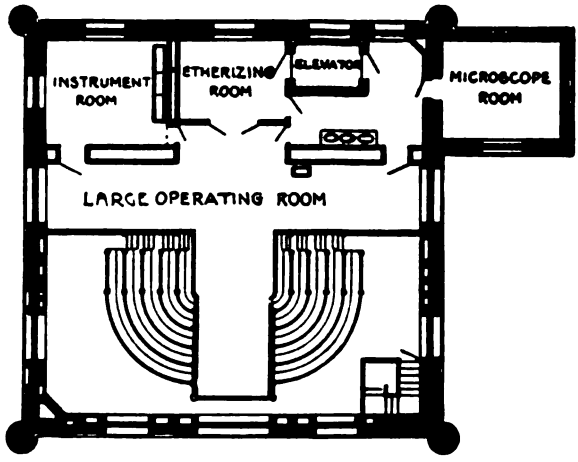
An excellent example of a special operating room is now to be seen at the Johns Hopkins Hospital. The gynæcological department being found to need a place to be used exclusively for operative work, a building was erected for that purpose in 1891. It was placed conveniently near the private ward for women. A plan of it is shown in Fig. 1797. Its convenient and simple arrangement, and its ingenious special devices, make it an admirable model of a fitting provision for its work.

The building comprises a large operating room, 25.8 by 25.9 feet, the floor of which is covered with Sinsig tiles laid upon lime of Teil arches, and the walls are wainscoted to the height of four feet with Tennessee marble. The walls are plastered with King's cement, which furnishes a hard, smooth, and non-absorbent surface. Adjoining the operating-room is an etherizing-room, 10 by 12 feet. Communicating with this is a recovery-room of the same size, with an adjoining bathroom and water-closet. The building has also a supply water-closet, dressing-room, and photographic room. It is heated by steam and ventilated by a shaft. The floor of the building is on a level with the floor of the main corridor, and the building is one story in height. The operating-room is lighted by two windows looking west, a large double window

looking north, and a large skylight. The windows and skylight are of obscured glass, so that the light which enters is thoroughly diffused, and strong and annoying cross-lights are prevented. The lighting is by both gas and electricity. The structure is of brick, with a slate roof, and corresponds in general appearance with the other buildings upon the grounds. The only departure from the method of heating adopted in the remainder of the buildings is in the location of the heating flues at a height of six feet from the floor, it having been found by experience that this arrangement prevents annoying draughts of air upon the patients.

The new operating-pavilion of the Presbyterian Hospital in New York was completed in 1892. The seating capacity of the main amphitheatre is one hundred persons; it is in the upper story of the two in the building, and is shown in Fig. 1798. It is finely lighted by large skylights and three great side lights on the north, south, and east. The wainscoting and floor are of marble, and the doors are heavy slabs of the same material. In the basement story, which is on a level with the corridor communicating with other parts of the hospital, there are two other operating-rooms to be used when seclusion is desirable; there are also a recovery-room and an etherizing-room, and those for instruments, etc. This building is a remarkable example of the adaptation of stone and iron to special devices of construction, excluding the use of wood almost entirely.

Fig. 1798.



Operating Pavilion, Presbyterian Hospital, New York.

The Roosevelt Hospital, in New York City, presents the most remarkable structure of this kind that is now in existence. It is the William J. Syms operating theatre, a memorial building, for which the bequest was $350,000. It was completed in 1892, and was equipped at a cost of about two hundred thousand dollars; and the residue provides a fund for its maintenance. It is two stories high in front and three stories in the rear. The amphitheatre occupies the centre of the building, and is lighted by a glass dome with a northern exposure, admitting the rays of light above and behind the audience; as far as possible the light that illuminates the operating-table is made to enter the room from behind the observer, and nearly parallel with his line of vision, with the exclusion of all cross-rays. The plan of the first floor may be seen in Fig. 1799.

Dr. Charles McBurney, Attending Surgeon to the Hospital, was made responsible, in the will of the donor, for the construction and equipment of the building. The main entrance on Fifty-ninth Street is intended for the students of the College of Physicians and Surgeons, the

buildings of which stand on the opposite side of the street. The broad vestibule has a marble mosaic floor, and Italian marble is used for the interior finishing and for the stairway leading to the upper seats of the amphitheatre. This has a seating capacity for 185 students, but 330 could easily be accommodated within its space. The seats, in six tiers, are of

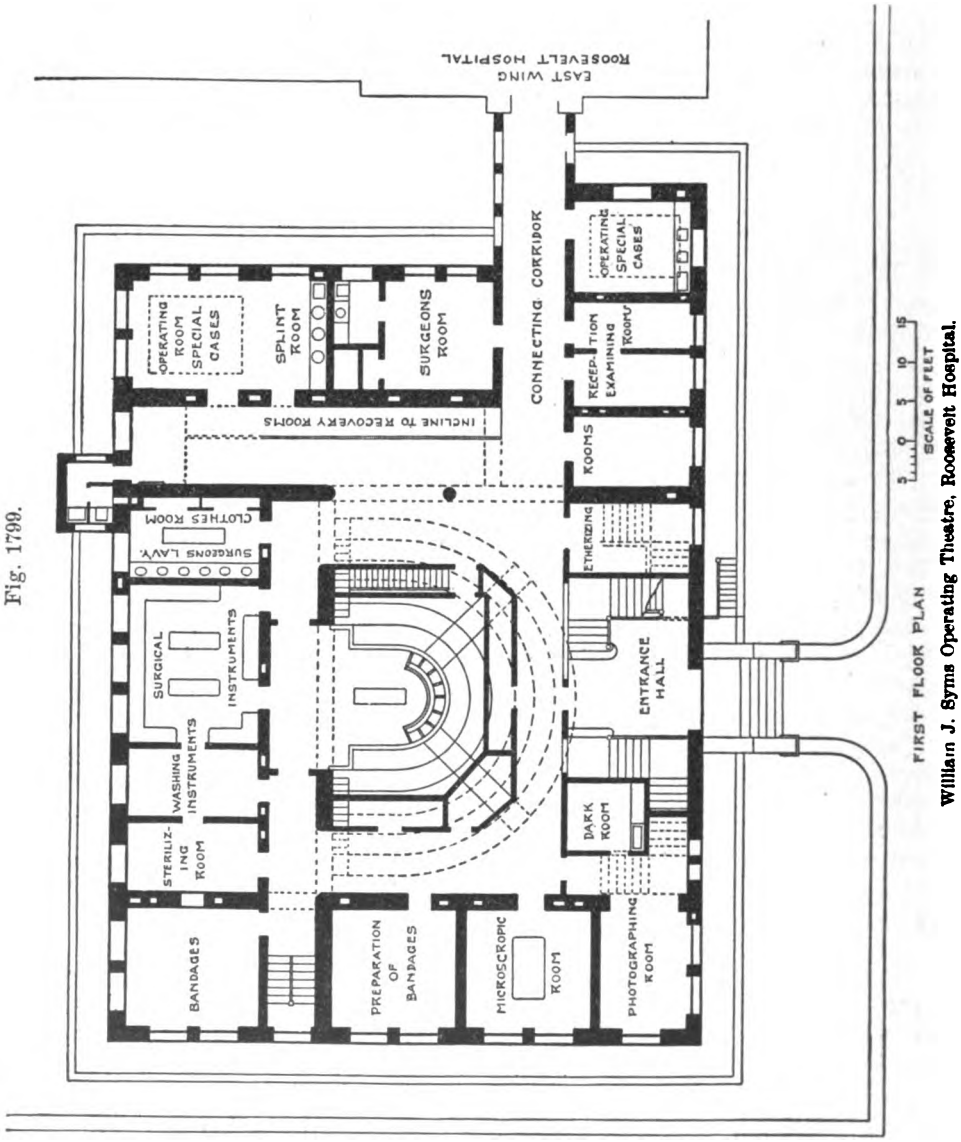


Fig. 1798.

wood, with wooden backs only; they are supported by being fastened to iron standards. A wainscot of pure white marble, 5 feet high, encircles the room at the top of the amphitheatre, while behind the operator an unbroken surface of marble rises from the pit to a line on a level with the top of the wainscot before referred to. Part of the pit extends backward to a recess lined with marble on every side, including its ceiling.

The floor is of marble mosaic, and its immediate surroundings are finished in marble and iron. The steps leading to the seats of the amphitheatre are of slate. Under the seats the sloping surface is of asphalt over thin concrete on wire lath. At the top of the entrance stairway are two rooms, one for surgical records and the other for the house staff.

A covered corridor leads from the Hospital to the building, on the level of its floor, all of which is laid in marble mosaic with angles rounded to meet a marble wainscot 5 feet high. Several of the more important rooms, where it is desirable to promote aseptic conditions, are fitted with doors of pure white Italian marble, 1¼ inches thick, hung on massive metal hinges, a single slab in each case forming a door. The special operating-rooms for septic and other cases are fitted with all conveniences, the interior and equipment being chiefly of marble, glass, and metal.

The front part of the building rises to two stories, and the central and rear portion to three stories above a basement. On the ground floor the outer rooms, east and west, are only one story high and admit light by skylights as well as by large windows in the outer wall, which, from their situation, have to be fitted with semi-opaque glass. The rooms are carefully and ingeniously fitted for the uses indicated in the plan: the instrument-rooms, for example, have cases of metal frames with glass doors, sides, and shelves, which were imported especially for their purpose; and there are many devices for promoting asepsis. An inclined plane has been provided, in place of an elevator, by which patients may be wheeled to the recovery-rooms, four in number, on the second floor. The sterilizing apparatus occupies a room by itself, and is one of the most efficient of the agencies employed to promote asepsis.

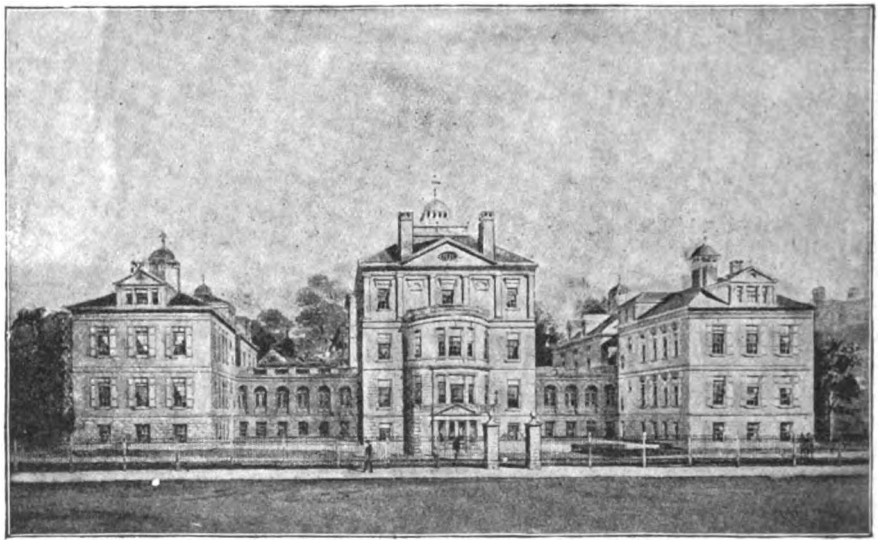
The lighting of the amphitheatre and of every other part of the structure is by the use of both gas and electricity. The warming is by steam; the air, taken at an elevation of 22 feet 8 inches from the ground, passes over steam pipes in great inlet ducts in the basement, and is forced by fans throughout the building; it is driven by one fan to the amphitheatre alone, and by a second fan to all other parts of the building. Fresh air, either hot or cold, as may be desired, is supplied to the amphitheatre through one hundred four-inch cast-iron inlets, commercially described as goose-necks, penetrating the inclined plane under the seats and directing the air, as it is received from the chamber underneath, upon the surface of the inclined plane. Ventilation is by aspiration through a large register near the ceiling, into a heated chamber which thence discharges its contents at the highest point of the structure, to the outer air. In all other rooms of the building separate vent-ducts rise directly upward to their exit openings, like chimney-flues—a system which entails the risk of down draughts of cold air in some of them if a careful balance of the forcing and extracting power is not always maintained.

The Pennsylvania Hospital, built in 1750, has pre-eminent claims to be called a historic institution, being the first general hospital in the country. It has been adapting itself to modern needs by some new construction in the last three years, and has now an excellent new home for nurses, and an out-patient department. Another important addition, recently completed, consists of three separate pavilions built

upon plans by the architect, Addison Hutton, in connection with the writer. These buildings are shown in elevation, fronting on Spruce Street, in Fig. 1800; beyond them, in the picture, appears the roof of the old hospital, which fronts on Pine Street.

The limitations as to the area and form of the lot led to a variation from the generally adopted plan of construction in the pavilions, in order to utilize best the whole space for these and future structures, and preserve the pavilion principle. The buildings are of brick and harmonize with the colonial style of the old hospital; they are so placed that their head-houses face in the opposite direction and toward the northern boundary of the lot, at a distance from it of twenty-five feet. The grade becomes lower here, permitting, for the central building, a carriage approach and an entresol entrance in the basement story,

Fig. 1800.



Memorial Pavilions, Pennsylvania Hospital.

which is ten feet high. A large bay is formed upon this end of the building and affords a fine oval room on the first floor, which with this mode of entrance is so treated as to give a special memorial character to this part of the structure. Beyond this the basements are mainly used for purposes of ventilation and warming.

The first-floor plan of the three buildings is given in Fig. 1801. They are connected by a basement corridor which extends to the central part of the old hospital; the corridor forms a covered way with open sides between the new pavilions on the first floor, and a terrace on the second floor. The distance between the buildings is 45 feet at the narrowest, and 50 feet where the large wards are. The sides of the buildings are free from projections. The central pavilion is of three stories; the rear half of the corridor on the first floor being a passage to the other wards, the adjoining rooms are arranged for special uses, and are not commonly occupied by patients. The memorial rooms and four special wards occupy the front end of the building. The east and west

pavilions, two stories high, have each two large wards of 20 beds each, and two special wards, besides the service-rooms. The large wards are 35 by 60 feet, with a central chimney and vent-shaft, and fireplaces. The height is 13½ feet, and the ceiling is somewhat arched at the sides and ends. It may be described as an elongated octagon ward with the ad-

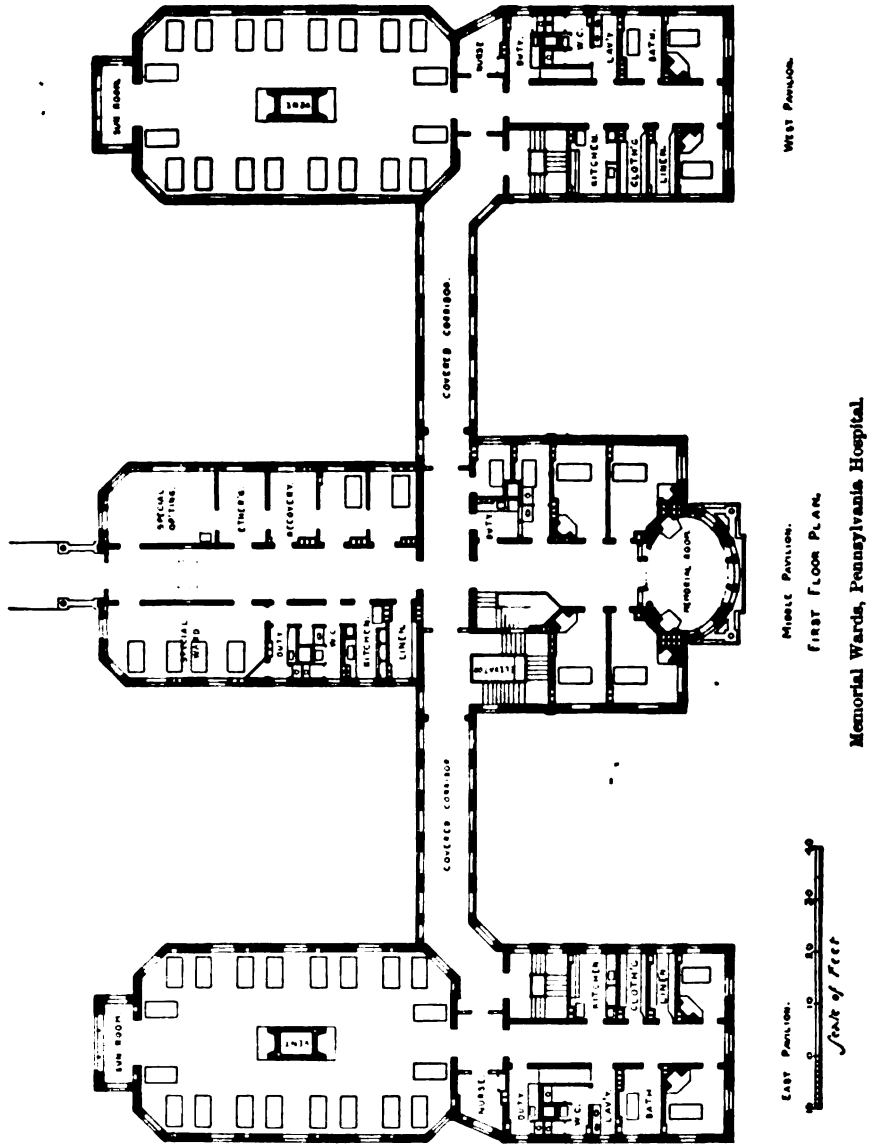


Fig. 1801.

Memorial Wards, Pennsylvania Hospital.

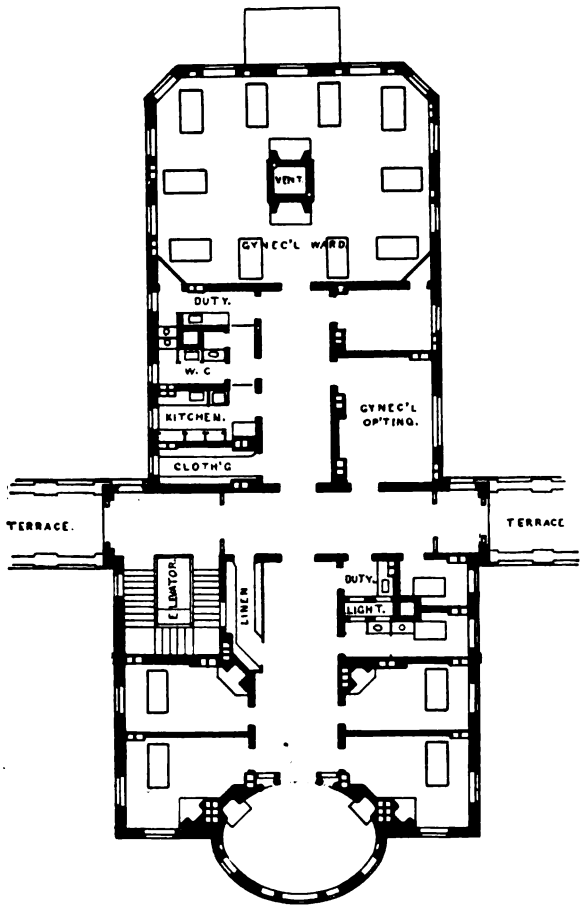
vantages both of that and of the rectangular form. It is exposed to sunlight and air on the east, south, and west, and nearly the whole of its exterior walls.

The second floor of the central pavilion is shown in Fig. 1802. This is provided with a large ward of ten beds, and with smaller special wards, an operating-room, etc. The third floor has a similar arrange-

ment of rooms, to be used for women and children; the latter have two wards containing 19 beds. The total capacity of the three pavilions is 140 beds.

The floors of the first story and all rooms in which there is any water-service are constructed throughout of iron beams and hollow bricks. The finish is plain and substantial, with all angles rounded; marble and tiles are freely used in appropriate places, including the operating-rooms, etc. All toilet-rooms have plumbing exposed, and are arranged with a central shaft for all pipes and for the independent ventilation of these special apartments which are cut off by a screen lobby from the main halls.

Fig. 1802.



Middle Pavilion, Second Floor, Memorial Wards, Pennsylvania Hospital.

The heating is by steam and indirect radiation. Elsewhere than in the large wards, which have special vent chimneys, the ventilation is by ducts leading to chambers in the roof. The outflow in all of these may be accelerated by heat from steam pipes. The extraction system is applied in its simplest form, so as to work automatically with the smallest need of attention.

SMALL HOSPITALS.

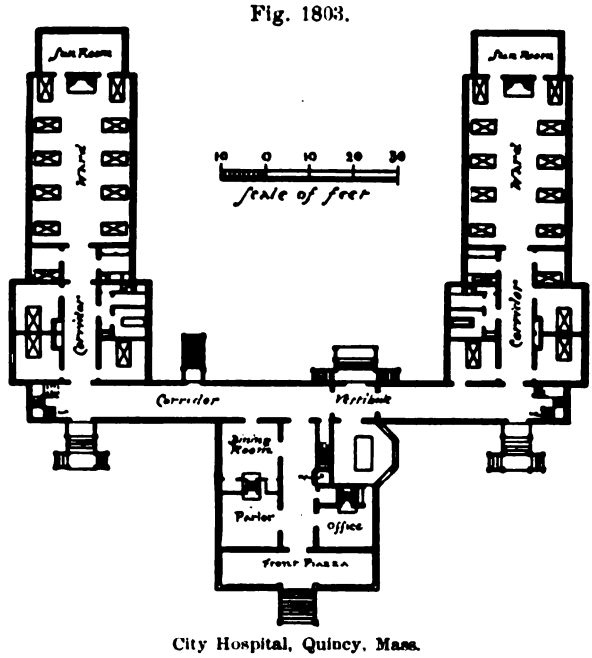
The City Hospital of Quincy, Mass., is an excellent example of what has been done in providing a hospital that, in the five years of its existence, has made a creditable record, and become a model of construction that others have followed. The hospital, with the administration house and one of its two wings, cost when completed for use $16,500, and with three and one-quarter acres of land, valued at $8,000, was given to the city by Mr. W. B. Rice. The furnishing cost about $3,000, and, with almost all the equipment, was paid for by societies and in-

dividuals; the hospital on completion was free from debt. The endowment fund for free beds reached the amount of $33,600 in the second year. The support of the hospital is aided by the city, by receipts from private patients, and by collection from various sources. A "Hospital Aid Association" also makes valuable contributions from its membership of seven hundred, at an annual fee of one dollar each, besides rendering aid in other ways.

The hospital has a capacity of twenty-five beds; it was opened in June, 1890, and admitted one hundred and two patients the first year, and one hundred and forty-six the second year.

The building is of wood, and occupies a fine elevated site with a southerly aspect. The plan, Fig. 1803, shows two one-story pavilions, one of which is not yet built. The pavilion contains fourteen beds; there are six rooms for private patients and a small ward in the second floor of the administration house. The heating is by steam, by indirect radiation; there are ventilating openings under the beds leading to a vent shaft two feet square, and others in the ceilings are connected with ventilators in the roof; there are also fireplaces in the wards and rooms. All rooms have rounded corners in the plastering; the hard pine floors and white-wood finish also have all angles rounded. The plumbing is modern, with all pipes, etc., exposed, and the drainage is good.

Fig. 1803.



City Hospital, Quincy, Mass.

The hospital is under the charge of a matron, who is required to be "an educated and skilful nurse." There is a regularly organized training-school, and some income is derived from the employment of pupil nurses outside of the hospital. A corporation of over three hundred members elects twelve trustees, who control the management of the hospital through an executive committee. There is a medical board that nominates the members of the medical and surgical staff, which includes physicians of both regular and homœopathic schools. The details of organization and management here given afford a good example of the method adopted in many of the small hospitals.

The Mary Hitchcock Memorial Hospital, completed in 1893, at Hanover, N. H., in the neighborhood of Dartmouth College, is an excellent example of the double pavilion plan of construction. It is the generous gift of Mr. Hiram Hitchcock, of New York, by whom its benefits are bestowed upon the college, medical school, and the town and country

around. The perfection of the building is due to the aim of the donor to provide everything desirable as a hospital requirement, and the construction is of the best in materials and workmanship. The writer was permitted to act in an advisory capacity in the planning and construction; and a more detailed description than the present one may be found in Burdett's work on hospitals.

The hospital consists of four buildings, three belonging properly to

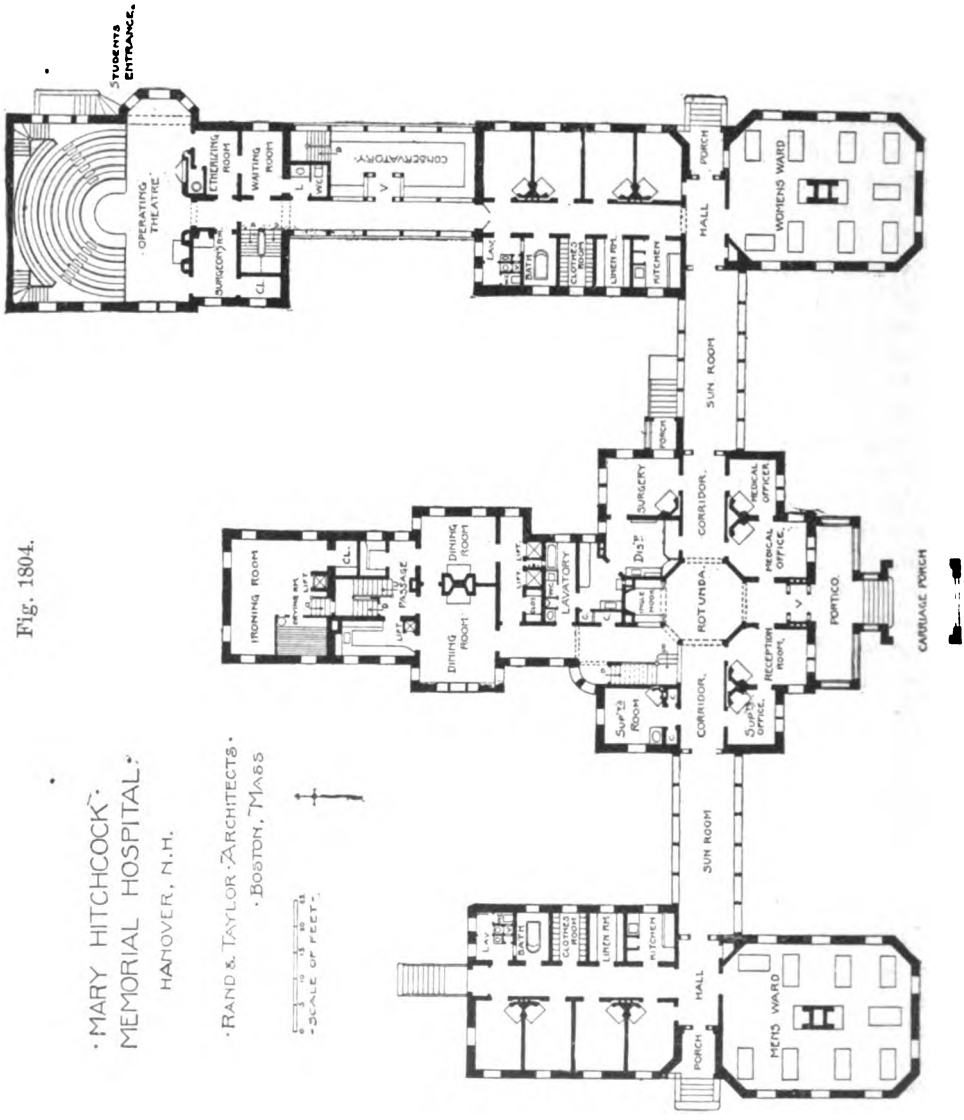


Fig. 1804.

it, and a fourth, a surgical operating-theatre, being designed for the special purposes of the medical college. The cut (Fig. 1804) shows the first floor of the four buildings. The material is of Pompeian brick of a mottled yellow-gray color, and the ornamentations are in a light-colored terra-cotta. The roofs are of light-red Spanish tiles. Their domed form is an outward expression of the fact that the interior con-

struction throughout is of the "cohesive system," by which all ceilings are formed of layers of vitreous tiles laid as shallow arches, or higher domes, over the rooms, and sustaining the floors above. This is an adaptation to modern use of the early Italian and Spanish dome construction, and this building is the first in America planned especially for the modern application of this method throughout. The inner partition walls being all of brick, there is a unity of fireproof construction, largely of vitreous and non-absorptive materials, including the outer walls. There is no iron or wood for the support of stairways or other construction, and only the floors and slight finishing around doors and windows are of hard pine, except where the woodwork is of oak, in the first and second stories of the administration building. Here, in the main hall, the first floor is laid in marble mosaic; and in the connecting corridors, serving as sun-rooms and leading to the pavilions, there are tiled floors. In the lavatory and bathrooms, operating-theatre, and conservatory or sun-room, and in all of the basements, the floors are of granolithic cement. The stairs are of marble, slate, or cement. The outer walls are hollow, and the plastering is upon the brick. The cost of the building, ready for use, was something over one hundred thousand dollars, exclusive of the surgical building.

The plan of the first floor presents the arrangement of the wards and rooms with much detail, to which little need be added. The entrance hall of the administration building, which faces the south, leads to a rotunda which is finished in marble and oak, with an appropriate tablet, giving it a memorial character. The second floor contains eight private rooms in the main building, and the service rooms, etc., are in the rear extension, with an intervening cross lobby. The third floor has accommodations for twelve nurses. The one-story pavilions contain each a ward for ten beds and four private rooms; the capacity of the hospital is thirty-six beds. The ward, 28x36 feet, has an arched ceiling at the height of 13 feet, and while it has all the advantages of a round or octagon ward with a central chimney and vent-shaft, its general rectangular shape is better for convenience of service and arrangement of furniture. The bathroom and lavatory, with a screen between, form together a lobby surrounding the inner apartment containing the water-closet, etc. The surgical building has a high-domed roof, showing handsomely the tiled construction, in which are ample skylights.

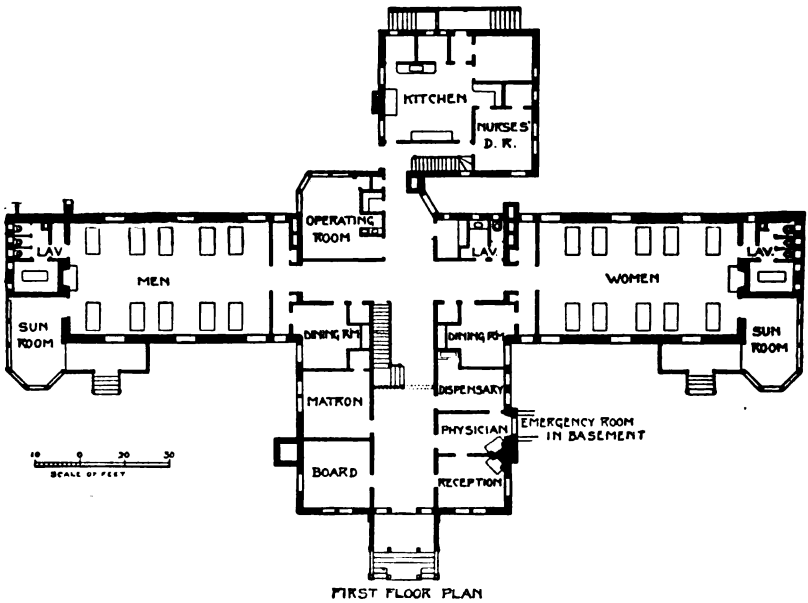
The heating is by steam and indirect radiation in all wards and rooms. The warm-air inlets are near the floor and mainly under or near to windows. The boilers are placed in a deep basement under the surgical building. The ventilation of the latter is by the chimney, with a central smoke-flue. In the wards it is by the central chimneys also; elsewhere there are vent-chambers in the roof to which the ducts are led from the rooms. There are openings under the beds in the large wards, connecting with the base of the large chimney, and in other rooms near the floor and ceiling, into ducts which rise mainly in connection with the chimney stacks. The rooms for nurses and servants, in the second and third stories, are warmed and ventilated by the transom system; the warm air, abundantly supplied in the halls, enters through the open transoms, and after traversing the room, aided by the chilling it receives at the windows, makes its exit by vent-openings near the floor in the interior walls. The ventilation, as a whole, is ac-

complished by a simple and effective application of the extraction system, and renders it easy to change the air of the wards and rooms at least three or four times an hour when desired.

The plumbing is fitted with the best modern appliances; all pipes and traps are exposed, and discharge into risers of soil-pipe in pipe-shafts which serve also for the ventilation of these special apartments. All water-pipes also have their risers in these shafts, the waste heat from those for hot water aiding the ventilation. The furnishing selected by Mr. Hitchcock is of the best materials and admirably suited to the strictest hospital requirements.

The Arnot-Ogden Memorial Hospital, at Elmira, N. Y., opened in 1888, is an excellent example of modern American hospitals of this class. It is a private benefaction, and was built as a memorial of the Arnot and Ogden families. According to Burdett's classification it is of the single pavilion type, or straight plan, consisting of two pavilions

Fig. 1805.



Arnot-Ogden Memorial Hospital, Elmira, N. Y.

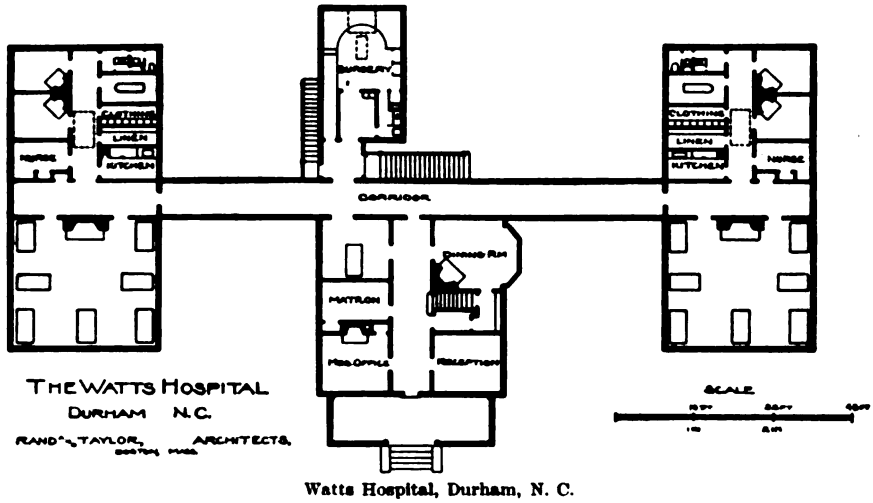
placed end to end with the administration interposed. The plan (Fig. 1805) shows the hospital as originally built: a surgical ward of 14 beds, with an operating-room having a mosaic floor and marbleized walls, has since been added in the rear of the ward for men, as also a small building for the isolation of special cases. The administration block is of three stories; on the first floor are the offices, etc., as shown in the plan; on the two floors above are the maternity and children's wards, private rooms, and the sleeping-rooms of the nurses. The total capacity is between 40 and 50 beds. The general wards are of one story only; there is an open fireplace in each, with steam-heating by indirect radiation, and a propulsion fan. The material is brick, hard-wood floors, and the interior walls are painted. The cost of the buildings, including heating apparatus and plumbing, was about $72,000;

and to this may be added $14,000 for furniture and sundries. There is a training-school for nurses. The hospital is supported by small endowment funds and endowed beds; there are, too, paying patients, and the city and county and various railroads pay for the care of others; and there are charitable donations from a variety of sources for the care of the poor.

The Watts Hospital, at Durham, N. C., is situated near the grounds of Trinity College; it is for the use of the community and of the college, and the medical students of the latter will have the privilege of attending the clinics at the hospital. It is the gift, with complete equipment and endowment, of Mr. George W. Watts. Five acres of land are set apart for the hospital, which has been built and furnished, ready for use, at a cost of about $25,000.

The object in view was to build the most effective hospital that could be had at moderate cost. The form of construction is simple, the low

Fig. 1806.



Watts Hospital, Durham, N. C.

pitch and broad overhang of the roof suggesting a Spanish style and having a picturesque effect. There are five buildings: the administrative block has two stories and basement; the surgical building stands next in the rear; and the two pavilions, to the right and left, are connected by a roofed corridor which can be enclosed by glass panels in winter. The three buildings last named are each of one story. In the rear of all is a low one-story building containing the autopsy room, mortuary, and a carriage shed. The first-floor plan of the principal buildings is shown in Fig. 1806.

The capacity of the hospital is twenty-two beds; fourteen are in the open wards, and of the private rooms two are on the second floor of the administration block. Its foundations, etc., are of brick, and North Carolina hard pine is used for all woodwork and exterior finish of the superstructure.

The heating is indirect, and ample vent openings are provided near floor and ceiling, and under the beds. The finish is absolutely plain, with rounded edges and curved inner angles. The plumbing is simple

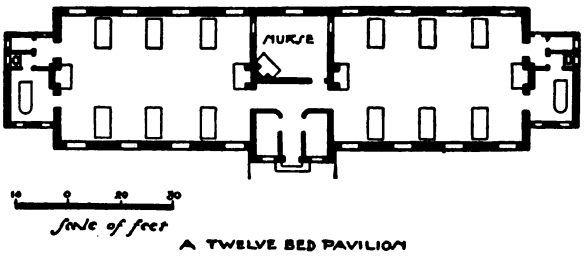
and strong, and the pipes and traps are exposed. The lavatories have tiled floors, and that of the operating-room is of asphalt. At the rear of the same lot it is intended to build hereafter a small contagious hospital. Taken altogether, here is a good example of what can be done for a moderate amount of money to meet the need of a town of 10,000 inhabitants, allowance being made for latitude and climate.

Hospitals for Infectious Diseases.

The relations between hospitals and the public whom they serve are rapidly developing in recent years with the advancement in sanitary science. There has been greater progress in these matters in England than in America, in respect to the general establishment of sanitary control for the repression of infectious diseases.

The admirable work of the Metropolitan Asylums Board in London stands as a model for the effective organization of hospitals and disinfecting stations for the protection of the poor, and the whole community alike, from the dangers of infectious and contagious disease. It has been demonstrated by experience that the value of a permanent isolation hospital is in its providing the means of isolating at once the earliest cases of disease, and thus preventing the epidemic instead of leaving it to be battled with when it has got full sway. In Burdett's work, the admirable chapters on this subject are most instructive. Valuable and precise information as to the best methods may be found in that book, and in Dr. Thorne's report On the Use and Influence of Hospitals for Infectious Diseases, which forms a part of the Tenth Annual Report of the Local Government Board for 1882. Among the plans given by Dr. Thorne is that of the Warrington Hospital. As a good type of such English hospitals, a plan of one of its small pavilions is shown in Fig. 1807.

Fig. 1807.



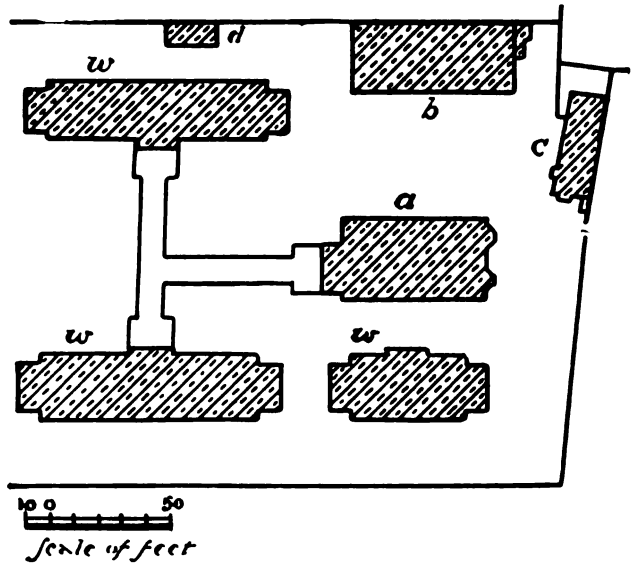
Twelve Bed Pavilion, Warrington Hospital.

A common arrangement is to group together a number of such small pavilions, and to connect them by a covered way, open at the sides, with an administration block.

The Warrington Hospital is of brick; its arrangement is shown in the block plan, Fig. 1808. There is a two-story administration block, *a;* two ordinary ward pavilions, *w, w;* a special detached pavilion with like interior arrangements, except that its wards are reduced to a capacity of one bed each, *w;* a lodge at the entrance, *c;* and two groups of out-buildings, *b, d.* One of the latter contains a laundry, disinfecting chamber, ambulance shed, mortuary, and store for wood, coals, etc.; the other contains two hand-vans to be used in connection with the stove, and a store for garden tools, etc. These forms of pavilion are two of the four prescribed by the Local Government Board.

The disinfecting apparatus is a "Ransome stove," otherwise well known as the Notttingham self-regulating disinfecting apparatus, in which articles passed through it are subjected to a temperature of 250° F. by dry heat. It consists of a cubical iron chamber, encased in wood with an intervening layer of felt, access to the interior being had by double doors. For disinfecting stations the chamber has doors on opposite sides, and is placed in the partition wall between two rooms—an "infected" side into which articles are carried, and a "clean" side from which they are removed. The furnace is placed at a lower level, and

Fig. 1808.



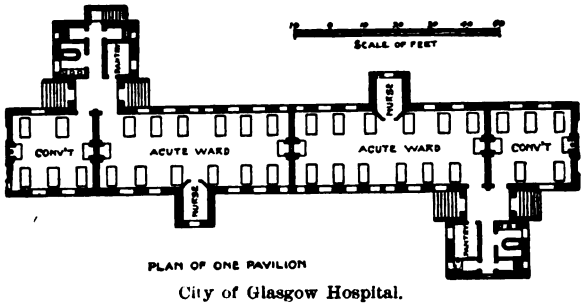
Warrington Hospital, Block Plan.

heat is generated by burning gas. There is an automatic regulator. A full description is given in Dr. Thorne's report, pp. 210 to 214. An approved form of apparatus employing steam confined under pressure is Lyon's patent steam disinfector, one of which is in use at the Johns Hopkins Hospital. This is an expensive apparatus and somewhat difficult in its method of working. These and other forms of apparatus, and experiments in testing them, are described by Dr. Parsons in his report to the Local Government Board, in 1884, on disinfecting by heat. A good résumé of this subject may be found in A Manual of Public Health, by A. Winter Blyth, published by Macmillan & Co., 1890, in the chapters on disinfection by heat and by chemicals, and on the principles of construction of isolated hospitals.

The Fever and Small-pox Hospitals of the city of Glasgow form an extensive establishment, which was completed in 1887. The Small-pox Hospital has ten wards in five pavilions, and the Fever Hospital has twenty-six wards in thirteen pavilions. The pavilions are of one story, and are alike in form and arrangement; they are detached, and are arranged in groups with respect to their isolation and to the administration and service buildings. One of these pavilions is shown in Fig. 1809. The two hospitals occupy a country estate of 33 acres, with large gar-

dens and pleasure grounds, at Belvidere. The Fever Hospital was begun in 1870, the first pavilion being of wood. In 1879 the erection of brick pavilions was begun, and now all are substantial structures of that material. Ample and excellent accommodations are furnished for physicians and nurses. The cost of the Fever Hospital was about £76,000. The Small-pox Hospital is completely isolated by a boundary wall. The whole cost of it was about £30,000. A remarkable reduction has been made in the death-rate of the city since the opening of this hospital, due to a variety of causes, not the least among them being the efficient labors of Dr. Russell, the Officer of Health. This hospital affords a most striking demonstration of the profit of guarding the public health.

Fig. 1809.



City of Glasgow Hospital.

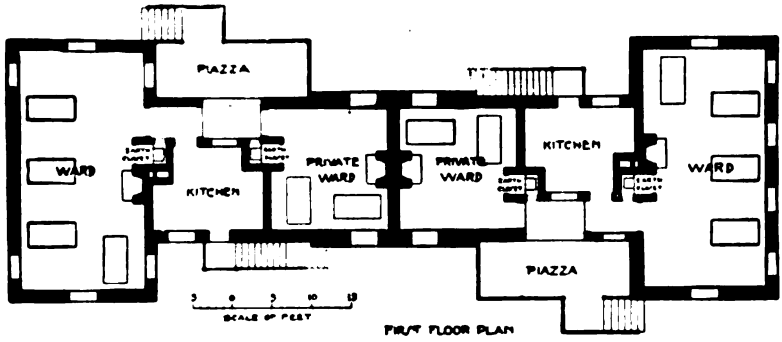
The English have realized, more than any other nation, the importance of isolation of infectious patients. In other European countries, like preventive measures against infectious diseases are enforced. There are established regulations for sanitary inspection and the organization of hospitals. Many forms of disinfecting apparatus have been invented; some of them are stoves employing dry heat, but steam is commonly used to gain a high temperature, and for applying moist heat in the disinfecting chamber. Some of these disinfectors are portable, and, being comparatively inexpensive, can be supplied to the several districts of large cities, and to smaller towns. A number of illustrations of these are given in A Treatise on Public Health, by Palmberg and Newsholme. The work is largely a translation from the French, published by Macmillan & Co. in 1893. The great expense of steam disinfectors delays their introduction into this country. There is an apparatus at moderate cost, now widely used in the smaller towns of Denmark, made by Reck, of Copenhagen, and by the Blackman Ventilator Company in London. It is 3 x 3 x 7 feet, and costs about $350, including boiler and fittings. It works upon the principle of keeping the steam under a slight constant pressure in contact with the contents for thirty minutes. The wetting of the disinfected articles, by the condensation of steam upon opening the chamber, is prevented by allowing a stream of cold water to flow through the apparatus after the steam has been shut off.

The Cambridge Hospital, in Massachusetts, has recently received an addition of a building for infectious and contagious diseases. It is on the grounds of the hospital, at an effective distance from it, and near the bank of the Charles River. The material is brick, and the symmetrical halves of the building are so arranged as to be entirely independent, and without means of communication except by going around the house, out of doors. It is of one story, except that a nurse's room in the attic for each section is accessible by an outside stairway.

The plan is shown in Fig. 1810. The construction is simple and sub-

stantial, as designed by Dr. Wyman; it is for the treatment of such cases of diphtheria, scarlet fever, etc., as may occur in the hospital or may be received from the vicinity. This plan is a modification of one of those of the Local Government Board already referred to. Here it

Fig. 1810.

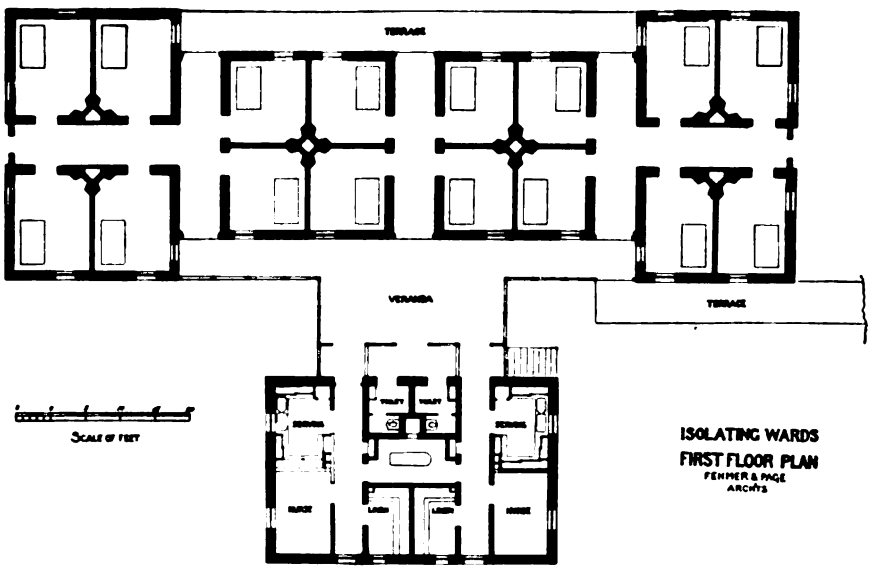


Contagious Disease Ward, Cambridge Hospital.

is improved by entrance lobbies to the wards, more windows, and access to closet without exposure in cold weather. A bath-room would further improve it.

A new isolation ward at the Massachusetts General Hospital, recently opened, presents some unique features. It is designed for the seclu-

Fig. 1811.



Isolation Ward, Massachusetts General Hospital.

sion of various patients requiring isolation, such as are found in the wards of every large general hospital, like those affected with the milder infectious diseases, and the delirious and somewhat noisy patients who may also attempt to escape. The exterior and main walls

are of brick, and the partitions are of terra-cotta blocks. The first-floor plan is shown in Fig. 1811.

Connecting with the main hospital is a basement corridor, over which is a terrace approach to the first floor; the veranda to the entrance has movable sashes at the sides, and a glass roof, which covers the space between the wards and the annex containing the service-rooms. The terrace and veranda floors are of stone flagging, and the remaining floors are of mosaic tiling supported on iron beams and tiled arches. The walls have a marble wainscoting three feet high; above this there is painted adamant plastering, and all angles at floors, walls, and ceilings are rounded. There is a fireplace in each room, and steam heating by indirect radiation, with mixing valves at the foot of each fresh-air inlet duct. Ventilating registers, near floor and ceiling, open into the vent-shaft in the central chimney of each group of rooms; this shaft is heated by steam-pipes to insure the outflow of foul air. A peculiarity of the arrangement of the rooms is that their several groups are separated by cross corridors with glazed doors at each end opening upon the verandas, or terraces; these corridors extend upward to the roof of the building, forming windowed gables, and afford abundance of light and ventilation, with the effect of isolating opposite rooms as if they opened to the outer air.

The Boston City Hospital, under the management of Dr. Rowe, is showing, in a remarkable manner, the tendency of the times in these matters. With the rebuilding of its surgical operating-theatre, a large addition is being made of accessory rooms for special kinds of surgical work, sterilizing apparatus, etc., in the best modern modes of construction. An extensive pathological building and mortuary, with clinical laboratories, have been liberally planned under the advice of Dr. Councilman, and are just completed. An important group of buildings, constituting an elaborately perfected Hospital for Contagious Diseases, has recently been occupied. It is isolated from the main hospital, upon an adjoining city lot, and its principal parts are the administration and domestic blocks, a house for 60 nurses, and two pavilions, each of two stories, accommodating a total of 136 patients in special wards for men, women, and children. A unique feature of the pavilions is, that because of the restricted area upon which they had to be placed, the three several sections of each building are separated by cross corridors opening to the outer air at each end; these are open from basement to roof, and have iron stairways. Here and elsewhere there are floors of marble mosaic or asphalt, walls of enamelled brick, and cement ceilings. Quite in contrast with the plan of employing a number of small detached pavilions, these carefully devised arrangements appear to be satisfactory for efficiently affording the isolation of the various groups of patients.

The definite knowledge that has now been gained by the scientific tests of disinfection establishes a basis for its practical application. According to Parsons, Sternberg, Blyth, and others, heat is undoubtedly entitled to the first place among the agents available for the destruction of infectious material external to the bodies of living animals. In nearly all the important infectious diseases of man and the lower animals, it is safe to assume that the temperature which kills the tubercle bacilli (212° F.) will be sufficient to accomplish disinfection. Ample

allowance is made, in directing the disinfection of all kinds of infectious material, by subjecting it to a boiling temperature for half an hour, in either water or steam. Exposure for ten minutes to steam under pressure, to raise the temperature to 221° F., will accomplish the object. The fact that the spores of certain bacilli found in the soil resist a considerably higher temperature than this has led to undue exactions in the use of heat. Esmarch has shown that dry heat is less effective than moist heat, and that superheated steam is less so than streaming steam at 212° F. Exposure to moist heat at twenty pounds pressure—temperature about 230° F.—destroys the most resistant spores in twenty minutes. A temperature of 240° F. is effective almost immediately. The simplest way of disinfecting articles of clothing and other articles not injured thereby, is to immerse them in boiling water. Cholera germs are killed at 126.6° F., and typhoid germs at 138.8° F. by exposure for four and ten minutes respectively. Infectious excreta of these diseases may be disinfected by adding three or four times their amount of boiling water. Sulphate of iron or chloride of zinc, in solution herewith, will deodorize and disinfect at the same time. This is a good rule for domestic and hospital use. The chemical disinfectant that is of practical value, and prompt in its action, is good chlorinated lime, which should contain at least twenty-five per cent. of available chlorine. A solution in the proportion of six ounces to one gallon of pure water being made, one quart of it may be used for the disinfection of each discharge in typhoid fever, cholera, vomited matter, etc. Then the contents of the vessel being well mixed, it should stand for at least one hour before they are thrown out. Infected sputum should be discharged into a cup half full of the solution.

The great activity in hospital work in all the civilized world is but meagrely indicated in these few examples available for selection to illustrate recent progress. The like activity in the profession of nursing has been alluded to in the beginning of this article. It is a significant sign of the times that whereas twenty years ago the training of nurses was doubtfully regarded as likely to create a kind of "nurses that would know too much," there is now a distinct movement to extend the period of training in response to the demand that "they should know more." It has come to pass that, during the past decade, a nursing-reform has also been established in hospitals for the insane. These hospitals are now being built as detached pavilions, with better classification and domestic effects than in the old palatial style of construction. The work of the hospitals and asylums of the world was never in a more promising condition than it is to-day.

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